

**SOLID WASTE MANAGEMENT IN URBAN FRINGE
SETTLEMENTS: THE CASE OF WINTERVELD, PRETORIA**

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ABSTRACT

Governments and municipalities in the developing world face the challenge of rapid environmental deterioration in the growing informal settlements along the urban fringes. Waste management, its efficiency, or lack thereof, is becoming an increasingly urgent issue. In this thesis, Winterveld, located approx. 50 km north of Pretoria, is studied as a typical example of the problems and bottlenecks related to solid domestic waste management in a mixed urban fringe settlement. While the formal parts of Winterveld receive waste removal services, the – much larger - informal parts are not being provided with such services.

A wide range of methodologies was employed to assess the current status of waste management and related environmental problems. Policies and actual service delivery by the City of Tshwane, responsible for providing waste removal service to the area, were investigated; surveys were conducted among waste removal contractors in and around Winterveld, and the residents from both formal and informal settlements. Field surveys were conducted to identify environmental problems on site, dumping sites and their change over time were mapped and digitized on orthophotos. Vegetation surveys complemented the fieldwork, as illegal dumping sites often are masked by vegetation.

The following aspects were investigated: 1) the efficiency of governmental and municipal efforts regarding waste removal in informal Winterveld; 2) environmental and health problems caused by improper handling of waste; 3) the residents' attitudes towards waste management; 4) possible solutions to the problems.

The findings revealed that Winterveld is not an exception from other informal settlements with regards to waste management. People are of the opinion that waste management is the sole responsibility of the government thus the residents are doing little to improve their own area. Government initiatives which include provision of facilities for waste management are misused and vandalised by the residents. Dumping along the roads, according to some residents is used as a call to the government to attract attention that the residents need removal services.

The initiatives by the municipality should ensure that solid waste management facilities are socially acceptable and environmentally and economically sound. It is therefore very important to involve the community when investigate technologies that will benefit the economy and the environment maximally. Informing people may encourage them to change their negative attitudes by making them feel as an important part of waste management, this will eventually compel them to cooperate and play a positive role in waste management. Until such time that they change their attitudes, there is little hope that they will appreciate and protect the facilities provided.

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ACRONYMS

CTMM	City of Tshwane Metropolitan Municipality
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
IEM	Integrated Environmental Management
GDP	Gross Domestic Product
GIS	Geographical Information System
IWM	Integrated Waste Management
LCA	Life Cycle Assessment
MSW	Municipal Solid Waste
NWP	North West Province
NWPSoER	North West State of Environment Report
OFS	Orange Free State
RSS	Random Systematic Sampling
SIA	Social Impact Assessment
SoER	State of the Environment Report
SWM	Solid Waste Management
TOSF	Tshwane Open Space Framework
UK	United Kingdom
USA	United States of America
WRC	Water Research Commission

1. INTRODUCTION

1.1 Research problem and aim of study

For the past decades, cities in South Africa, like in all developing countries, have been experiencing an increasing influx of people from rural areas as well as neighbouring countries, seeking a better quality of life. Most of these people do not get the jobs they had hoped for, and thus find themselves living in unfavourable conditions on the urban fringes because they cannot afford decent accommodation in the cities. As cities grow bigger, land use, settlement patterns and density, lifestyle, and pressure on the environment also change respectively.

Rapid growth of population density together with improving living standards along urban fringes of developing countries as well as the lack of accessibility or structure of waste management result in the generation of waste in quantities so large that municipalities and other responsible authorities are faced with the difficulty managing it. The condition is exacerbated by the lack of cooperation from the residents who seem to regard waste management as a sole responsibility vested with the municipality. The lack of responsibility from residents at household level will eventually induce health-threatening conditions in their environment.

Driving past any one of South Africa's informal settlements, the urgent need to develop waste management strategies that would improve the impact of waste on the environment is most evident. A common waste disposal practice in informal settlement is simply to dump it as far away as possible from one's own yard. As a result, waste accumulates along roadsides and public open spaces, as illustrated in **Figure 1.1**, a situation which unfortunately is by no means unusual. Consequently, the environment along rural-urban fringes presently experiences growing stress, not only from other and well-researched negative issues such as rapid population growth with respective over-utilization of natural resources and environmental degradation, but increasingly so from waste dumping and pollution. At the same time, health and social problems and economic constraints are more evident in these urban-fringe areas than in the cities and suburbs.



Figure 1.1: Illegal dumpsite along Winterveld Road, Winterveld

Waste has been dumped outside of the individual plots and homesteads, i.e. outside of what is perceived as the sphere of individual responsibility. The photo does not refer to casual dropping of waste along walkways, bus stops, or taxi ranks, but to the deliberate dumping of large quantities of waste of multiple origins.

Photo: LR Moiloa, October 2004, i.e. six months after the National 2004 Elections.

This study on Solid Waste Management (SWM) addresses aspects of environmental impact and degradation along urban fringes, which result from poor management of solid waste, specifically of domestic (household) waste. The need for this research was mainly triggered by the observed amount of littering and dumping, especially in the growing informal settlements of Gauteng. Even though the observation of littering is more evident in informal settlements, the lack of adequate waste management seems to be a current problem throughout South Africa. In Gauteng, the problem is amplified by the province's greater population density and industrial activity; Gauteng Province having the highest population of above 9 million people, yet it has the smallest territory of all provinces in South Africa (Statistics South Africa: 2002).

Domestic solid waste consists of a mixture of a diverse range of materials such as glass, metal, paper, plastic and organics, but comprises only relatively small amounts of each component. This diverse and constantly varying composition therefore makes domestic solid waste one of the hardest sources of waste to manage efficiently, with respect to, among others, sorting, recycling, and final deposition.

Due to the ever-increasing population growth and related environmental stress, reliable provision for pollution control and waste disposal improvement is necessary. In the last decade of the 20th century, it became increasingly apparent that Municipal Solid Waste (MSW) ceased to be a technical problem, but more and more became a management problem which must be borne by all concerned and affected parties (Hugo, 2004). Unless steps are taken to properly monitor and control the generation and disposal of waste across all sectors, and to provide well-managed disposal and recycling facilities, the problem of waste will continue to pose and increasing threat to human and environmental health.

The **aim of this study** is to investigate environmental aspects of solid waste management practices in Winterveld, including their perception by the local residents and respective contractors.

This aim comprises the **following objectives**:

- To identify the authorities, departments and contractors, responsible for waste management in Winterveld, for both formal and informal parts of the settlement;
- To identify and, if possible, assess the quantity and type of waste generated;
- To assess the standard of waste management and the compliance to national and international legislation;
- To assess the satisfaction level of the community regarding waste management service delivery;
- To accurately identify illegal dump sites, and to evaluate the difficulties in mapping them on the ground and by means of high-resolution orthophoto analysis;
- To then establish, for the first time ever, a geographical/ spatial data base, at least for a limited study area, on the location of waste disposal and illegal dumping sites in Winterveld;
- To identify the level of awareness of environmental and health problems created by poor waste management;
- To identify standards as well as potential shortcomings, weaknesses and failures of the present waste management system, in order to provide background information on future improvement attempts;

Winterveld was selected as a study area for three reasons:

- Firstly, it is located at the north-western boundary of the Tshwane Municipal Area, a typical urban fringe settlement, with all respective problems of urban growth, long commuting distances, lack of infrastructure and income.
- Secondly, it comprises mixed settlement types, consisting of both, formal and informal sections. The residents of the formal parts receive waste management services in more or less the same way as residents in the city, while the informal settlement residents are mainly left to fend for themselves. Just by visual observation, waste management in this area seems does not to exist at all, a situation typical for informal settlements in South Africa. The mixed settlement type and poor road networks; hence lack of accessibility of whole sections, make it difficult for the municipality to deliver reliable SWM services.
- Thirdly, Winterveld represents numerous similar settlements facing the above-mentioned problems resulting from strong population growth by migration. Migrants come from as far as Malawi, Zimbabwe and Mozambique, in search of jobs, either in the mines or in the industrial areas (e.g. Roslyn and Akasia) in the fringes of the City of Tshwane City. The population pressure in Winterveld by this rural-urban and cross-border migration has resulted in an increase of informal settlements and has exacerbated environmental problems severely.

1.2 Structure of study

The structure of the study is illustrated in **Figure 1.2**.

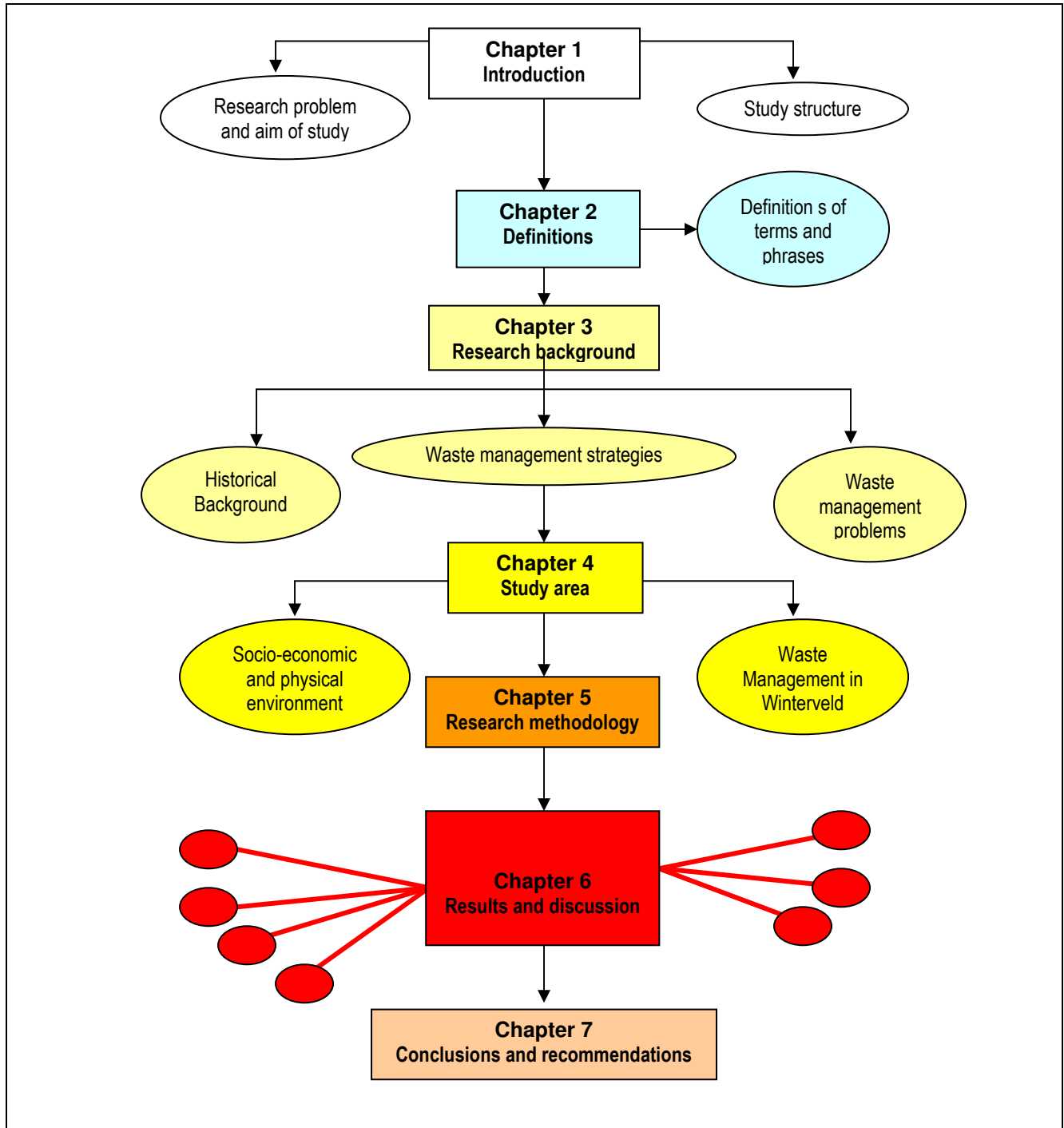


Figure 1.2: Structure of the study.

Chapter 2 establishes a knowledge base of waste- and waste management-related terminology.

Naturally, the management of waste can be carried out in various ways, but all forms of waste disposal result, one way or the other, in side effects that adversely affect and pollute the environment (Hugo, 2004). Chapter 3 therefore provides a wide information background on historical, technical and practical aspects of Solid Waste Management (SWM), both in South Africa and internationally, including the relevant legal framework. The difference between SWM in cities and in the rural-urban fringes is then established.

Chapter 4 describes the socio-economic and physical environment of the Winterveld study area as well as the current waste-related strategies and problems in this urban-fringe settlement.

Chapter 5 outlines the wide range of research methodologies which were employed to achieve the research objectives. In Winterveld, different authorities are responsible for waste management, for both formal and informal settlements (e.g., municipality, government departments and private contractors). These role players and their responsibilities are identified and information is obtained on the quantity and type of waste generated, storage and handling methods used from point of generation to the point of final disposal. Environmental impacts at each stage, i.e. during waste generation, storage, collection/ transportation, recycling/recovery, treatment, and final disposal, are analysed. Furthermore, a first spatial information base is established for a portion of the most densely populated part of informal Winterveld, to identify the strengths and weaknesses of SMW in Winterveld; this included digital and statistical methods.

Chapter 6 presents results and their discussion, on (i) the current waste management strategies and their efficiency or lack thereof, (ii) the impact of the present situation on the Winterveld environment, and (iii) possible strategies for improvement. The geographical distribution of waste disposal and/or recycling facilities in relation to the location of settlements, settlement patterns and population density is extremely crucial in this respect, as it provides spatial information on the distances which people living in the informal settlements have to travel if they are to take their own waste to the collection points or disposal sites.

The investigation will help to determine whether waste management in urban fringes is effective, efficient and sustainable. It will ultimately help to establish strategies of waste management and appropriate technologies that also could improve the current conditions in Winterveld. Chapter 7 provides these conclusions and recommendations, both for future solid waste management in Winterveld and other urban-fringe settlements, and for future research.

2. DEFINITIONS

This chapter aims to provide a terminological background for the research, and to introduce the wide range of sometimes overlapping terms related to waste management, its methods and strategies. It is crucial to define and understand the various components of the field (basic procedure, purpose, worldwide trends and problems) associated with waste management in general as they are used in this study. As waste management can be understood as one component of environmental management, the respective definitions of environment and its management must be established first, followed by terms pertaining to waste, pollution, and waste collection techniques.

2.1 Environment and management terms

Environment, refers to all external conditions and factors, living and non-living (chemicals and energy), that affect an organism other specific systems during its lifetime (Miller, 2004). O'Callaghan (1996) defines environment comprehensively as the surroundings and conditions in which an organism operates, including living systems (human and other) therein. "As the environmental effects of the organism may reach all parts of the world, the environment in this context extends from within the workplace of the global system" (O'Callaghan, 1996, p. 101).

There are various other definitions of **environment**, but they all have common aspects for developing growth, namely; living things, climate, soil, atmosphere, water (surface and ground), associated cultural, social and biotic aspects.

In this study, the most relevant definition is, of course, the **South Africa definition of environment**, as put by Hugo *et al* (1997), "environment is the sum of surrounding elements, influences and situations which affect the life and the habitat of both an individual organism and a collection of organisms. Those elements are (1) air water and land; (2) all forms of life; (3) all ecological processes and interactions; (4) physical infrastructure created by man; (5) socio-cultural structures and process; (6) product safety; (7) community safety and health; and (8) occupational safety and health."

Fuggle *et al* (1992) define **management** as the execution of planned controls to achieve desired outcome. This definition is very important for this study, as the term 'management' is attached to most techniques which aim at improving environmental performance of human activities.

Given the broad scope and diversity of specialisation involved, there is no concise universal definition of **environmental management**, (Barrow, 1999). Formulating the definition of 'environmental management' from definitions of both 'environment' and 'management'; it can therefore be put as, planning and controlling human activities as to achieve the desired outcome without destroying/depleting - see the items on the list above- , natural resources, forms of life, ecological processes, infrastructure, culture, safety and health.

Environmental management comprises those aspects of the overall management function that determine and implement the company's environmental policy. It considers local and global environmental problems, relevant legislation, standards, costs, taxes, and overall environmental impact. It concerns the formulation and control of environmental policies and environmental systems with respect to energy, water, materials and waste, (O'Callaghan, 1996). Environmental management can therefore be simplified, for easy reference as execution of environmental plans to achieve long-term sustainable use of natural resources and the environment.

Integrated Environmental management (IEM) is the co-coordinated planning and management of human activities in a defined environmental system to achieve, and balance, short and long term environmental objectives", (Steyn, 2000, pp 13, after South Africa, 1998a). IEM can also be described as a procedure concerned with the conservation of resources, increasing utilisation of efficiencies, and reduction of waste and its associated environmental pollution. It integrates environmental management with environmental engineering and so covers problems, legislation, standards, economics, policy and impact with respect to energy and air pollution, water and effluents, the use of materials, the production of waste, the production of land pollution, noise abatement, products and eco-labelling, (O'Callaghan, 1996).

IEM is designed to ensure that environmental consequences of developments are understood and adequately considered in the planning process. It is intended to guide, rather than impede, the development process by providing a positive, interactive approach to gathering and analysing useful data and presenting findings in a form that can easily be understood by non-specialists, (Fuggle *et al*, 1992). However, the integration of environmental concerns into public policy depends on an open system government, a wide disclosure of information and an informed citizenry.

Hugo (2004) defines **IEM** as a holistic procedure, which directs the complete process of harmonising new developments within the community fabric, to ensure optimal land use. Environmental Impact Assessment (EIA) and Social Impact Assessment (SIA) naturally form an

integral part of this process. IEM seeks to reconcile conflicting interests and concerns, minimise negative impacts, and enhance positive results; it is an approach that seeks to integrate impact assessment and evaluation into planning and decision making, (Barrow, 1999). To apply principles of IEM to Waste Management, therefore, would be an ideal approach. Any new improvements that the authorities would like to bring into waste management should embrace IEM.

2.2 Environmental impact and assessment methods

Any effect in the physical and socio-economic environment that arises from a cause, either directly or indirectly, related to the project, is termed an **environmental impact**. An impact on an environmental system arises where a human activity, in a form of a development, changes the system from the position it would normally be, to some other state, now or at some time in the future (Meiklejohn, 2003). It is crucial to understand that the production of waste followed by dumping or lack of waste management, causes major impacts, first on the physical environment, but, in the long run, also on the socio-economic environment of any given area.

There is no universal definition for the term **environmental impact assessment (EIA)**, so it is best treated as a generic term for a process that seeks to blend administration, planning, analysis and public involvement in pre-decision assessment (Barrow, 1999).

EIA is a process that forces the consideration of the environmental effects of development proposals. Wathern (1988) defines EIA as “a process for identifying the likely consequences for the bio-geophysical environment and for man’s health and welfare for implementing particular activities and conveying this information, at a stage where it can materially affect their decision, to those responsible for sanctioning the proposal”. EIA should therefore be understood as the administrative or regulatory process by which the environmental impact of a project is determined. Establishment of waste management facilities may include activities that require environmental authorisation according to the Environment Conservation Act. Such activities include construction of landfill sites, recycling and transportation of waste and incineration of waste.

Life Cycle Assessment (LCA) is a method/ tool/ technique used to quantify environmental burdens; it is based on an inventory of environmental factors for a product, process or activity from the abstraction of raw materials to their final disposal (O’Callaghan, 1996). This tool is increasingly been used to predict and compare the environmental impacts of a product or service from “cradle to grave” (beginning to end), (Franke *et al*, 1995).

The **LCA** technique examines every stage of the life cycle, from the winning of raw materials, through manufacture, distribution, use, possible re-use/ recycling and to final disposal. For each stage, the inputs (in terms of raw materials and energy) and outputs (in terms of emissions of air, water and as solid waste) are calculated, and these are aggregated over the lifecycle. The inputs and outputs are then converted into their effects on the environment, i.e. their environmental impacts. The sum of these environmental impacts then represents the overall environmental effect of the lifecycle of the product or service (Franke *et al*, 1995).

Friend (2003) puts **LCA** as “the tool used to assess the environmental aspects and potential impacts associated with a product, process or service, by compiling an inventory of relevant energy and material inputs and environmental releases; evaluating the potential environmental impacts associated with identified inputs and releases; interpreting the results to help you make a more informed decision”.

2.3 Waste, pollution and environmental degradation

Environmental degradation is a depletion or destruction of a potentially renewable resource such as soil, water, air, grassland, forest or wildlife that is being used faster than it is being naturally replenished. If such use continues, the resource becomes non-renewable (on a human time scale) or non-existent (extinct), (Miller, 2004).

Pollution, according to Miller (2004), is an undesirable change in the physical, chemical or biological characteristics of air, water, soil, or food that adversely affect the health, survival or activities of humans or other living organisms. Pollutants can enter the environment naturally (for example, from volcanic eruptions) or through human (anthropogenic) activities such as burning of fossil fuels. Illegally dumped or generally toxic waste is, respectively, a potentially major source of pollution.

The Environment Conservation Act (Act No 79 of 1989) as amended, defines **waste** as: “any matter whether gaseous, liquid or solid, or any combination thereof, which is from time to time designated by the Minister by notice in the Gazette as an undesirable or superfluous by-product, emission, residue or remainder of any process or activity”, WRC Report No 629/1/96. This is not necessarily a scientific definition but empowers the Minister to determine what constitutes waste.

A more scientific definition of **waste** is “an unwanted by-product, damaged, defective, or superfluous materials of a manufacturing process”, (Dyer *et al*, 1999; pp 1). Most often, in its

current state, waste has, or is perceived to have no value and therefore we want to get rid of it. Emission of waste to the environment (i.e., any routine or accidental emission, effluent, spill, discharge or disposal to the air, land or water) results in pollution that contaminates or degrades the environment.

Waste can also be described simply as a by-product of human activity. Physically it contains the same materials as are found in useful products; it only differs from useful production by its lack of value at present state. A basic way to deal with waste therefore is to restore value to it, at which point it will cease to be waste. The lack of value can in many cases be related to the mixed, and in many cases, unknown composition of waste (Franke *et al*, 1995).

Domestic waste is defined as waste generated on premises solely for residential purposes and purposes of public worship or education, including halls or other buildings used for religious or educational purposes, but does not include builder's waste, bulky waste, garden waste or special domestic waste [City of Tshwane Metropolitan Municipality (CTMM) Waste By-Laws].

2.4 Waste Management and collection types

The process of collecting waste efficiently from all sources and disposing it in controlled sites could justifiably be labelled **Solid Waste Management (SWM)**. The process, however, does not effectively begin with the generation of waste. Thereafter it includes all activities ranging from storage through reclamation and disposal (WRC Report No 629/1/96). Solid waste management is only one of the methods used to put pollution under control in order to reduce the stress on natural systems to the breaking point.

Sustainable (SWM) is a strategy for achieving the environmental quality in both the developed and the developing world. "The quantities and composition of the waste must be known in order to be able to apply the suggested economic instruments," (Bolaane *et al*, 2001). Sustainable SWM entails many strategies discussed in the review on waste-related issues in Chapter 3.

The **Integrated Waste Management (IWM)** approach maintains that waste management can be planned in advance. This is because the nature, composition and quantities can be predicted at each point in the material cycle (South Africa, 1998). Although such an approach surely would be worth aiming for, any real scenario, also such as the one of Winterveld as presented in this study, contains too many variables and unknowns which render this postulated "predictability" far too idealistic.

Kerbside collection: The waste collecting company/contractor removes waste from the kerbside outside a dwelling or from the property itself.

Communal collection: Household members take their waste to a collection container where the waste is deposited. The container, usually a skip, is then emptied by the waste collection agency.

2.5 Settlement definitions used in this study

Urban: Areas that fall under urban local authorities such as City Council and Metropolitan Council.

Urban fringe (also known as peri-urban) - usually dense settlements on the edge of metropolitan areas, and they have no local authority.

The term of **Informal settlement**, according to CTMM, refers to one or more shacks constructed on land, with or without the consent of the owner of the land or the person in charge of the land. This definition is used throughout this study, for the informal parts of Winterveld.

An **unauthorized informal settlement** is any informal settlement which is not recognized by the Municipality as an authorized informal settlement and which will not be legalized and upgraded as a formal township in terms of the Municipality's existing housing policies, but will be demolished and removed in terms of these by-laws.

A **shack** is any temporary shelter, building, hut, dwelling or similar structure which does not comply with the provisions of the National Building Regulations and Building Standards Act (Act 103 of 1977). Shacks exist in Winterveld either as large clusters in open spaces, e.g. floodplains, which are cleared by municipal action from time to time, but then occupied again; or, as multiple small clusters in the backyard of plots within the formal parts of the settlement.

3. LITERATURE REVIEW

3.1 Introduction

There are currently numerous discussions on ecological footprint, and they primarily turn on (i) waste and (ii) energy use, two of the most crucial components to be included in environmental management (Khalema, 2000). This thesis focuses on the issue of solid waste management in the rapidly growing urban-fringe settlements where waste management, or the lack thereof, plays an even more crucial role than in many other anthropogenically influenced environments.

This section provides a conceptual, theoretical, and historical background on solid waste, its environmental implications, its management and the development of waste management strategies over time.

The environment can be regarded as a sink for all waste produced by human activities (Frankie *et al.* 1995, p 5). According to Barrow (1999), “Humans have always polluted their environment without taking note of any adverse impacts. However, real problems followed urban development, population concentration, industrial activity and applied chemistry”.

Developments apparent in the late 20th century stress the urgency that environmental management should be got right in order to minimize and/or avoid, global pollution, loss of biodiversity, and soil degradation. It is therefore the role of environmental management to aim towards long-term sustainability when planning and implementing such developments, to improve human well-being, mitigate or prevent further damage to the earth and its origin (Barrow, 1999).

The 1990’s were the period in which it became apparent that waste issues were not only simply technical problems but also creating management problems of considerable proportions (Fehr, 2003). As a measure towards solving these problems, new strategies such as Solid Waste Management (SWM) were implemented. Different countries not only used different philosophies but also different models to put certain common philosophies into practice (Fehr, 2003). Among the different approaches are incineration in Sweden; bulk landfill in Argentina, the USA and South Africa; and bulk anaerobic digestion in Canada and Spain (Medina 2000).

All these technologies require various amounts of financial input and thus are not all suitable for developing countries or urban fringe communities, so the options for Winterveld must be carefully weighed. In the Winterveld case, IEM could play a role in identifying the practice which best suits its

physical and socio-economic environment, while LCA would be used to identify the most efficient practice, both from an environmental and economical standpoint.

3.2 Historical background

Attempts to control the misuse of the environment can be traced as far back as biblical times, but laws specifically designed to regulate environmental deterioration have only been a product of the last 300 years (Fuggle and Rabbie, 1992). The 1970s are known as the decade when environmental issues first gained wide public interest, and when, throughout the world, environmental concerns were first channelled into legislation and environmental protection laws (Fuggle and Rabbie, 1992).

Within the framework of this study, Waste Management is investigated as one of the tools suitable to protect the environment from the hazards to which it is exposed. Just as in the case in environmental management, techniques and strategies used for waste management have evolved since the existence of humanity, and were passed on and developed from generation to generation, and from place to place. This present chapter provides a historical background on waste management strategies, examples and trends, from the early simple methods to the most advanced techniques used today. Various strategies were adopted in different countries and regions, at different times. It is important though to look first at how the environmental deterioration through poor waste management started to be of a concern to man.

In the following sections, changing historical approaches from different regions, Europe, America, and South Africa, will be discussed critically.

3.2.1 Historical development of waste management

Table 1 and **Table 2** provide two historical overviews on changing waste management approaches in the United States of America (USA) and in other First World States. The two tables are adopted from two different authors; while Barbalace (1999) mainly focuses on America, Hickman and Eldredge (1999) provide numerous additional details on the changing waste management practices in Europe.

Table 1: Chronology of waste and management practices (Barbalace, 1999)

Date	Notes
6,500 BC	North America -Archaeological studies shows a clan of Native Americans in what is now Colorado produced an average of 5.3 pounds of waste a day.
500 BC	Athens Greece - First municipal dump in western world organized. Regulations required waste to be dumped at least a mile from the city limits.
New Testament of Bible	Jerusalem Palestine - The Valley of Gehenna also called Sheol in the New Testament of the Bible "Though I descent into Sheol, thou art there." Sheol was apparently a dump outside of the city of that periodically burned. It became synonymous with "hell."
1388	England - English Parliament bars waste dispersal in public waterways and ditches.
1400	Paris France -Garbage piles so high outside of Paris gates that it interferes with city defence.
1690	Philadelphia - Rittenhouse Mill, Philadelphia makes paper from recycled fibres (waste paper and rags).
1842	England - A report links disease to filthy environmental conditions - "age of sanitation" begins.
1874	Nottingham England - A new technology called "the Destructor" provided the first systematic incineration of waste in Nottingham, England. Until this time, much of the burning was accidental, a result of methane production.
1885	Governor's Island NY - The first garbage incinerator was built in USA (on Governor's Island in New York)
1889	Washington DC - Washington DC reported that they are running out of appropriate places for refuse.
1896	United States - Waste reduction plants arrive in US for compressing organic wastes. Later closed because of noxious emissions.
1898	New York - NY has first rubbish sorting plant for recycling.
Turn of Century	New York - By the turn of the century, the garbage problem was seen as one of the greatest problems for local authorities.
1900	New York - Piggeries developed to eat fresh or cooked garbage (In the mid-50's an outbreak of vesicular exanthema resulted in the destruction of 1,000s of pigs that had eaten raw garbage. Law passed requiring that garbage had to be cooked before it could be fed to swine.
1911	New York City – NYC citizens were producing 4.6 pounds of refuse a day.
1914	United States - There was about 300 incinerators in the US for burning trash.
1920's	United States - Landfills were become a popular way of reclaiming swampland while getting rid of trash.
1954	Olympia Washington - Companies pay for return of aluminium cans.
1965	United States - The first federal solid waste management laws were enacted.
1968	United States - Companies begin buy back recycling of containers.
1970	United States - The first Earth Day celebrated, the Environmental Protection Agency EPA creates the Resource Recovery Act enacted.
1976	United States - Resource Conservation and Recovery Act (RCRA) created emphasizing recycling and HW management. This was the result of two major events: the oil embargo and the recovery of the Love Canal.
1979	United States - The EPA issued criteria prohibiting open dumping.
Today	United States - The list goes on.
Source: Barbalace (1999).	

The following table (**Table 2**) presents in detail the changing needs and solution in waste-related problems, mainly in Britain.

Table 2: Chronology of waste and management practices (Hickman & Eldredge, 1999).

3000 BC	Cretan capital, Knossos - the first recorded landfill sites were created.
2000 BC	China - Composting is known to have been a part of life during the European Bronze age. Bronze scrap recovery systems were in place.
> 2,500 y ago	Athens - Government open a municipal landfill site and decree that waste is to be transported at least one mile beyond the city gates.
1297AD	Britain - In response to the increasing amount of waste deposited in towns, a law is passed to make householders keep the front of their house clear from refuse. It is largely ignored. However, most waste is burned on household open fires.
1354	London - "Rakers" are employed in each ward to rake rubbish together, load it into carts, and remove it once a week
1407	Essex - It is ruled that household rubbish is to remain indoors until it can be removed by the rakers after which it is either sold as compost or dumped in the marshes. This preliminary attempt to manage and control waste is not particularly successful, but paves the way for further regulation.
1408	Medieval German cities - The wagons required to bring produce into the city and to carry out waste into the countryside.
1500s	Spanish - copper mines use scrap iron for cementation of copper, a recycling practice that survives to this day.
1588	Elizabeth I grants special privileges for the collection of rags for papermaking.
Early 1800s	Many people lived by selling what they could find in other peoples rubbish, even dogs' dung which was valuable as it was used by tanners for purifying leather.
	'Toshers' worked in the sewers, a dangerous and smelly way to make a living, but lucrative as they found coins, bits of metal, ropes and sometimes jewellery.
	'Mud-larks' scavenged on the riverbanks, and made a very poor living.
	London - 'Dustmen' collected the ash from coal fires. Over 3.5 million tons of coal were burned in a year.
	The dust was taken to dust-yards. Here men, women and children worked on the heaps of rubbish, sieving the breeze or coarse section of the dust. This is used as a soil conditioner and for brick making.
1848	Britain - the Public Health Act 1848 begins the process of waste regulation.
1874	Britain - Energy from waste begins its development as the first "destructor" is designed and constructed in Nottingham . Destructors were prototype incineration plants which burnt mixed fuel producing steam to generate electricity. During the next 30 years, 250 destructors are built in Britain . They are opposed on the grounds of emissions of ashes, dust and charred paper which fall onto the surrounding neighbourhood.
1875	Britain - The Public Health Act 1875 charges local authorities with the duty to arrange the removal and disposal of waste, starting an evolution of local authority power. This replaces the previously widespread practice of scavenging. The Act also rules that householders keep their waste in a "movable receptacle", the beginning of the dustbin, which the local authorities have to empty every week. A charge could be made for every day the bin was not emptied.
1890	The British Paper Company is established specifically to make paper and board from recycled materials.
By the late 1800s	Britain - Household waste is collected daily in moveable ashbins. The waste is sorted by hand, usually by women or girls, into salvageable materials, and coarser materials are sieved from fine ash (breeze). A large proportion of the waste is reused and recycled, e.g. glass and metals are returned to merchants, and the breeze and hard core from incinerated residue are used in building materials.
1898	Britain - The Association of Cleansing Superintendents is established, which today has evolved into the Institute of Wastes Management.
1907	Britain - An amendment to the Public Health Act 1875 extends refuse collection to include trade refuse and authorises local authorities to levy charges for waste collection.
1921	The British Waste Paper Association is established (initially as the Association of London Waste Paper Merchants) to help develop the trade in waste paper for recycling.
1930s	The manufacture of plastics from petroleum chemicals begins (<i>plastic products had been made from plants since 1862</i>).
	The production and manufacture of plastics grows slowly over the next 20 years. In the 1950s, production begins increasing sharply due to increases in different types and applications for plastics.
1930s,	Most house heating and hot water are provided by burning newspapers and coal in fires, hence the small quantities of paper and large quantities of dust in the bins. The small percentages of textiles, glass, and metals are also the result of recovery and reuse schemes.
1936	Britain -The Public Health Act 1936 rules that the accumulation of waste which is prejudicial to health, or a nuisance, is a Statutory Nuisance. Authorities are given the power to prosecute over uncontrolled dumping, cesspools and scavenging - a practice which often resulted in the scattering of refuse. The Act also prohibits building upon contaminated land and lays down regulation for the management of landfill sites, but these were mostly overlooked in

	the years that followed.
	During the world wars, waste regulation becomes less of a priority. Despite a rise in reclamation and recycling during the wars, the post-war years face the legacy of huge unsanitary and uncontrolled refuse tips especially surrounding the larger cities. Although local councils make efforts to legislate against the dumping of refuse, appalling situations develop throughout the country where vast tips up to a mile long burn continuously.
1947	The Town and Country Planning Act gives authorities planning powers over new waste management sites, but most of the existing tips cannot be controlled.
	During the post-war years, economics are against incineration, hence the domination of landfill in British waste disposal practice. Landfills are constructed at the most convenient cost and locations, with little thought of their environmental impact or consequences such as water pollution and methane gas
1956	The <i>Clean Air Act</i> is passed signalling a decrease in the number of open fires in homes as they are replaced by central heating fuelled by oil, gas or electricity. Consequently the composition of household waste changes from being predominantly ash, dust and cinder from fires, to being made up of other wastes such as food and paper which would previously have been put on the fire.
1960	A working party set up by the Duke of Edinburgh leads to the setting up of the <i>Royal Commission on Environmental Pollution</i> .
1960s	Private waste contractors begin to take over what had previously been considered a public works activity. In 1968, contractors come together to form the <i>National Association of Waste Disposal Contractors</i> .
1970s	The first serious waste regulations during the 1970s are introduced
1971	Report by the Royal Commission on toxic wastes, provides a catalyst for the first ever legislation to control hazardous waste. The consequent <i>Deposit of Poisonous Waste Act 1972</i> is drafted in 10 days and passed through Parliament within a month.
	<i>Friends of the Earth</i> launch their first campaign by returning thousands of bottles to Schweppes, an environmental stunt which successfully uses the media in bringing issues of waste and product disposability to public attention.
1974	Increasing concern over waste leads to the <i>Control of Pollution Act 1974</i> , which aims for a much wider control of waste disposal and regulation of sites, and begins a serious tightening up of waste disposal methods.
1977	The first bottle banks appear in Britain
1980s	The decade sees increasing public concern over waste disposal especially hazardous waste. The construction boom results in an estimated 1 million tonnes of illegally deposited waste lying around London at any one time. Those who produce the waste have no responsibility for it. Directives from the European Union begin to put pressure on the British government, and there are contentious issues such as the import of wastes, contaminated land and inadequate powers of waste regulators. The increasing number of private sector contractors in waste management begin to challenge the enforcements and self-regulation of the local authorities.
1986	Environmental protection finally gets included in the Treaty of Rome through the <i>Single European Act</i> .
1987	<i>The National Council for Voluntary Organisations</i> sets up a project called Waste Watch to promote and support waste reduction, reuse and recycling. Over fifteen years later, Waste Watch is an independent national charity working alongside local authorities, community and voluntary groups, businesses, industry and Government, providing advice, training and information from the Waste line, as well as practical support for action.
1989	The <i>Commons Environment Committee</i> inquiry, chaired by Sir Hugh Rossi, recommends that waste regulation pass from local authorities to a central body.
1990	The Government produces "This Common Inheritance", its first comprehensive <i>White Paper on the Environment</i> . This sets out a waste strategy that regards waste minimisation and recycling as priorities, and sets a target of 25% for the recycling of household waste by 2000.
	The subsequent <i>Environmental Protection Act 1990</i> separates waste regulation from operational work in local authorities and implements more regulations and controls. It replaces the 1974 Act with a new licensing system covering all controlled wastes and requires local authorities to consider recycling in their waste strategies.
1992	<i>The Duty of Care</i> is introduced, whereby anyone who "imports, produces, carries, keeps, treats or disposes of controlled waste" must take responsibility for it. Those who deal with waste are now given a duty to care for it, managing waste from its generation through to transfer and disposal.
	The <i>Eco-labelling</i> scheme is set up to recognise relative environmental impacts of similar products.
1994	An EU Directive introduces the idea of producer responsibility with regard to packaging waste requiring member states to set targets on the reduction and recovery of packaging waste. This was followed by the UK's Producer Responsibility Obligations Section 93 (Packaging Waste) Regulations .
1995	The Environment Act establishes the <i>Environment Agency</i> , replacing the National Rivers Authority, Her Majesty's Inspectorate of Pollution, Waste Regulation Authorities and some parts of the Department of the Environment. As a

	central body, its aim is to manage and regulate not only waste but also industrial pollution and water resources.
1996	The Government publishes its waste strategy for England and Wales , titled " <i>Making Waste Work</i> ". This document sets out plans for sustainable management of waste, and confirms the target of 25% of household waste to be recycled by the year 2000.
	The landfill tax introduced in order to encourage alternatives such as reuse and recycling, and promote waste minimisation.
1997	<i>The Producer Responsibility Obligations (Packaging Waste)</i> required businesses to recover and recycle 38% of their packaging, increasing to 56% by 2001.
1999	The Government releases " <i>A Way with Waste</i> ", a draft waste strategy for England and Wales updating " <i>Making Waste Work</i> ". The national waste strategy for Scotland is also launched, with specific goals for reducing special and industrial waste.
2000	A finalised waste strategy for England and Wales " <i>Waste Strategy 2000</i> " is published, setting revised national targets for the recycling or composting of household waste: 25% by 2005, 30% by 2010, and 33% by 2015. The " <i>Waste Management Strategy for Northern Ireland</i> " is launched, setting targets for household waste similar to " <i>Waste Strategy 2000</i> ".
2002	The EU Regulation on Ozone Depleting substances comes into force. Under this Regulation, any insulation foam or cooling circuits containing CFCs or HCFCs must be recovered from fridges and freezers prior to shredding and disposal.
	Waste Not Want Not, the Strategy Unit's report on Waste Strategy 2000, is published.
2003	The WEEE (Waste Electrical and Electronic Directive) is implemented. England will have to collect 4kg of WEEE from every household by 2006.
Source: Hickman Jr L. H. and Eldredge R. W., 1999	

The first municipal dumpsite was introduced as early as 3000 BC in the Cretan capital, the city of Knossos, and 500 BC in Athens, Greece (**Table 1 and 2**). With the ancient Greeks, open space was plentiful and piling of waste at dumping sites was not seen as a problem. However, beginning with the dawn of modern civilization and industrialisation, long-term landfills began to receive huge and ever-increasing amounts of waste, and governments were finally forced to look for alternatives. In England, recycling of paper was introduced as an attempt to reduce the amount of waste entering the landfill sites. This method was practiced in other countries such as China where recycling included almost any material that was of use, for example; scrap metals, paper, and others. Waste food and cow dung were also composted and used as natural fertilisers.

Legislative requirements were invented in the late 1800's in order to regulate disposal of waste. In 1836, Health Act was published in Britain, followed by Energy Act in 1848. These two acts ruled out indiscriminate disposal of waste and forced the communities to take their waste to the collection points and incineration centres where waste would be to produce fuel. The 20th century would qualify to be called the rise of environmental concern as more and more countries placed laws to regulate waste disposal activities.

Tables 1 and 2 clearly show that no strategy, technology or law has ever been, or ever will be, sufficient in the long run; hence the necessity for Waste Management to be continuously improving. The solution for today will not be good enough to solve waste problems of the next decade. Landfill

disposal and incineration of waste are the most commonly used strategies of the present time, but there will be cases, and already have been, when there is not enough land to bury all the waste; thus it is necessary to predict future trends and plan ahead of time.

3.2.2 Changing domestic waste composition over the past 100 years

Significant changes took place in the composition of household waste over the last 100 years. These changes can be traced back to the fundamental social and economic shifts which affect the way we live our everyday lives.

In early pre-industrial times, waste was mainly composed of ash from fires, wood, bones, bodies and vegetable waste. It was disposed of in the ground where it would act as compost and help to improve soil fertility. Respectively, ancient rubbish dumps excavated in archaeological digs in the United States of America reveal only tiny amounts of ash, broken tools and pottery, (Atkinson and New 1993). Everything that could be was repaired and re-used. However, the transition from a nomadic hunter-gatherer to a farming lifestyle meant that waste could no longer be left behind, and soon became a growing problem.

Apart from archaeological findings, it has always been a problem to quantify waste and its composition somewhat accurately. Only over the last few decades that there have been any real attempts to estimate the composition and quantities of household waste. **Figure 3.2** shows different waste materials and their quantities in relation to each other in the United States, over time.

Unfortunately, there are no such data available for South Africa.

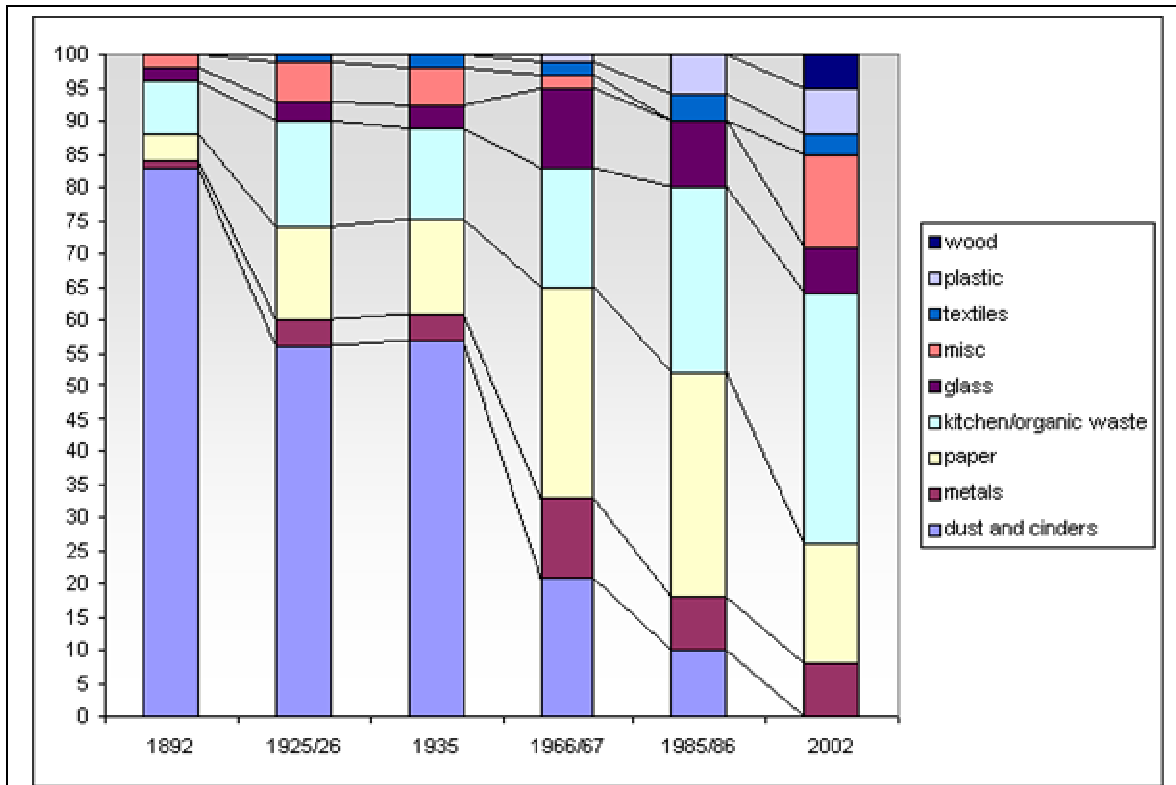


Figure 3.2: Changing composition of domestic solid waste in the USA from 1892 to 2002

The changing proportion of degradable and non-degradable waste illustrates the growing challenge for any waste management system.

Source: Atkinson and New, 1993.

Figure 3.2 displays the changing composition of household waste for the past century, for the United States, according to data from Atkinson and New (1993). The data from 1992 to 2002 are projections based on past trends. The reasons for the changing waste composition are manifold, but similar in most countries of the world, so that similar trends can be assumed:

- (i) The increasing urban lifestyle and general urbanisation. Many people now live in flats or converted houses where they rely heavily on electricity. Fewer people have fires to produce ash and cinders or gardens to dispose vegetable waste (Atkinson and New, 1993).
- (ii) Changes in society, such as increased use of automobiles, the rise of supermarkets, city edges settlements, and increased competition between traders, have led to an emphasis on the presentation and marketing of products and, consequently, to a steep increase in the volumes of packaging. This accounts for the rise in packaging materials such as metal and plastics, and for a decline in returnable bottles, as can be seen in **Figure 2**.

Solid Waste Management thus emerged as an essential specialised sector for keeping cities healthy and liveable (Ahmed and Ali, 2002). Tools for cleaner production such as LCA and SWM

have been widely applied on Waste Management Systems issues since the beginning of 1990s (Thomas, 2004).

Numerous other tools for cleaner production were studied, especially in the recent years, with the goal of reducing waste production. An international expert group on LCA for IWM was established in 1998 to support the development of LCA techniques for IWM. A series of international, scientific workshops on environmental analysis of waste management have been held so far, which indicate that waste management is not only an area of international concern, but has indeed become an established area of research (Thomas, 2004).

3.2.3 *The rise of environmental concerns*

From the earliest primitive human society, there have been attempts to dispose of solid waste safely (Ahmed and Ali, 2002). Four basic means of dealing with trash have been used repeatedly in history: dumping, burning, recycling, and waste minimization (Barbalace, 1999). The four basic means of disposal did not pose difficulties as habitations were sparse and disposal land plentiful. Disposal became problematic with the rise of towns and cities where large numbers of people started to congregate in relatively small areas in pursuit of better livelihoods. On one hand, the density of population and total number of people in these centres of congregation increased, and therefore the waste generated per unit area also increased. On the other hand, the land available for disposal of waste decreased in proportion.

Until the Industrial Revolution when materials became more available than labour, re-use and recycling were common practices. As an example, as early as nearly 4000 years ago, a recovery and re-use system of bronze scrap was in operation in Europe; there is also evidence that composting was carried out in ancient China, (Atkinson and New, 1993). Traditionally, recovered materials mostly included leather, feathers, and textiles. Recycling included feeding vegetable wastes to livestock and using green waste as fertilizer. Pigs were often used as an efficient method of disposing of municipal waste. Timber was re-used in construction and ship-building, gold melted down and re-cast numerous times. Later recovery activities included scrap metal, paper and non-ferrous metals.

The quantity and type of waste is probably related to the availability of resources more than to any other factor. For example; when a commodity such as petrol is plentiful and cheap, automobiles get larger and numerous (nobody thinks about future supplies). When it becomes scarce and expensive, smaller automobiles are developed and more widely and readily bought. This truth

applies to other commodities and products such as food: the more food supply, the more food, generally, tends to be wasted. People who have limited resources try to utilise as much as possible out of the resource before they can dispose was is no more of use.

3.3 Regional examples

3.3.1 United Kingdom

Waste Management strategies in the UK, a typical first-world example, are chosen to illustrate many of the immanent waste-related problems which also occur in other parts of the world. In past centuries, it had been common for Europeans – as well as elsewhere - to throw their garbage and even human wastes out of the window, as they assumed that stray dogs would eat whatever they threw out (Barr, 2004). During the past three decades, however, throughout most western countries, public support for environmental protection measures has grown consistently (Barr, 2004). Endorsement for a wide array of measures to reduce the human impact on nature and conserve resources has reached high levels among individuals, e.g. in the UK; the measures relating to a variety of environmental issues such as transport, waste management, water quality and green consumerism.

As in many other first and third world countries, the UK's historical approach to waste management used to be to simply to dump waste into pits in the ground (landfill sites) or, more recently, to burn it. Waste management and disposal techniques have however improved over the last 25 years. Most of this improvement resulted from regulation (using the law to set tighter controls and higher standards) and from the waste management industry's positive response to these regulations.

The UK government forced waste management strategies towards reducing, re-using and recycling more of the waste (Atkinson and New, 1993). Some form of disposal which will always be necessary should only be a last resort. Even since the regulations were first introduced in the 1980's, the volume of household waste in the UK has increased from less than 400 kg per person to over 500 kg per person per year. Such an increase was attributed to economic growth, social change, and waste collection methods (Atkinson and New, 1993).

The growth of waste production closely mirrors that of the Gross Domestic Product (GDP), while the increase in single-person households together with the increased use of wheeled-bin household waste collections has exacerbated the problem. Today in the UK, estimates indicate that each household throws away over a ton of waste annually (www.businesslink.gov.uk). In addition,

for every ton of products bought, ten tons of resources are used to produce them. Around 70% of household waste in the UK has the potential to be either recycled or composted. Despite the fact that the majority of the general public regard recycling as worthwhile, and over 65% of households have access to kerbside collection recycling schemes, only 14.5% of dustbin contents are recycled or composted (www.businesslink.gov.uk).

In 1996, the UK decided that there should be a significant move towards a more sustainable approach to waste management (Morris *et al*, 1998). They introduced a Landfill Tax to ensure that landfill waste disposal was properly priced to reflect its true environmental costs, and to help promote waste reduction, recycle and reuse of materials. The reports following the introduction of Landfill Tax indicated a modest reduction in the amount of waste going to the landfill from industry, but no change for domestic waste (Morris *et al*, 1998). From these observations, it still too difficult to pin point a strategy that universally solve problems related to waste management.

3.3.2 United States of America

Although Americans are considered more wasteful than similar civilisations of the past, it is noted that the nature of the waste varied greatly from one civilization, ancient and modern, to another in America (Barbalace, 1999). An archaeological account on native Americans in Colorado about 6500 BC states that 200 buffalo were killed in one day, 150 of them butchered, providing enough meat to feed 150 people for 23 days. The remaining unused material comprised some 18,380 pounds of bones, which under the conditions investigated were able to remain for 6500 years, while the soft tissue decomposed completely (Barbalace, 1999). In 23 days, 150 modern day Americans are assumed to produce about 14,150 pounds of waste, only some of which would decompose rapidly. Based on the weight of the bones that remained, the Native Americans in that clan produced about 5.3 pounds of waste/ day, as compared to 2.5 pounds/day presently, which is probably a rather moderate figure for middle class American consumption.

This archaeological quantitative example, of course, is drastically skewed, as there is no account of the population density, the frequency of such abundant wasting of material, and the lack of toxicity for the environment. Also, even though the bones of the slaughtering remained for thousands of years, their life span, eventually, will be considerably less than that of glasses.

As another historical example, the Mayan Indians of Central America had dumps which occasionally burned or even exploded. The Mayas also recycled at least some of their waste. Some

of the waste was trampled underfoot by household members, some was swept into corners. When the waste layer became too deep, it would be covered with dirt.

Managers of solid waste in the USA attribute much of improvements on solid waste management today to the severe problems caused for people, not by the waste itself, but by unpleasant side effects such as mosquitoes, flies, rats, swine, odour, and smoke. Mosquitoes, flies, and rats are particularly attracted to litter, open dumps, and open-burning dumps, but also live in close proximity of, or are particularly attracted to people living together in crowded spaces. The once-popular practice of feeding raw garbage to swine often killed the pigs, which caused a lot of concern for the pig farmers; also, the open-burning dump produced smoke and odours long after the flames were no longer visible. These undesirable attributes of existing practices eventually triggered the challenge for serious improvement in refuse management. The end of the 20th century's integrated solid waste management approach is thus a direct result of the changes which had commenced in the late 1940s (Hickman and Eldredge, 1999).

In the past, pigs used to be an important part of refuse management. Waste-food or the garbage portion of the refuse was routinely recycled as feed for pigs up until the late 1960s. Often the pig was allowed to wander over and eat dumped waste-food. In later years, it was discovered that the spread of vesicular exanthema (an eruptive disease in the veins of the pigs) in pigs was caused by raw garbage, or undercooked garbage that contained pork scraps. Vesicular exanthema was deadly to pigs and threatened to wipe out many piggeries. In the late 1950s, new regulations were established, requiring that the garbage be cooked to combat vesicular exanthema. This process failed because it was distasteful, expensive, and sometimes ineffective (Hickman and Eldredge, 1999).

In the 1950s, many urban areas used open-burning dumps because they reduced the volume of refuse received at the dumpsites and therefore extended the life of the site. However, the burning dumps impacted on local air quality. Similarly, smoking backyard incinerators which were very popular in the 1940s and '50s, were eventually also recognised as major contributors to air pollution in urban areas. Onsite open burning of commercial and industrial refuse was also practiced, but was eventually stopped in the 1950s (Hickman and Eldredge, 1999).

It is unclear as to when sanitary land-filling first became an idea, but it was learned with time that covering refuse with soil or ash could help to eliminate odours. Compaction was then added to the process as a means of packing more refuse into less space. In their early stages, however, sanitary

landfill methods lacked definition, legislation and technical guidelines. Issues such as compaction requirements, densities to be achieved, frequency and depth of cover placement, and limited access were not a part of the sanitary-landfill construction-procedure description (Hickman and Eldredge, 1999).

The tremendous growth of military bases as the USA mobilised for the Second World War influenced the formulation of methods for managing refuse as an essential part of the war effort. Studies by the US Army determined that the sanitary landfill was adaptable to changing conditions and would accommodate varying quantities of refuse with little significant change in equipment need or operating procedures. By the end of 1945, almost 100 cities in the USA were using sanitary landfills, and by 1960, some 1,400 cities were using sanitary landfills (Hickman and Eldredge, 1999).

It is interesting to note that these studies by the US Army provided several valuable contributions to the art of sanitary land-filling, including the recognition of the flexibility of a sanitary landfill, the application of equipment still in use in sanitary landfill construction today, and the use of the term cut and cover in land-filling (Hickman and Eldredge, 1999).

3.4 Environmental implications and costs of waste

The environment has the natural ability to break down biological wastes and put them back in the ecosystems (Chenje *et al*, 1994). However, natural systems have limits as to the amount of waste they can process, beyond which the systems could be permanently degraded, with potentially disastrous environmental consequences. An example of such could be the production of carbon dioxide: green plants are capable of extracting carbon dioxide from the atmosphere and produce the oxygen through photosynthesis process. However, destruction on green vegetation can reduce the capacity of the environment to extract carbon dioxide and to produce oxygen. At the same time, some of the fossil fuels and cut vegetation are converted into fuel and burnt, producing more carbon dioxide. The consequences are the global warming, reduced crop production, and many other related problems.

The best way to manage the environment is to identify and address the main problems that contribute to its deterioration and the decline of natural resources. Waste is among the earliest environmental problems that were formally recognised. Environmental problems concerning the management and disposal of waste can be divided into two major areas; (1) the depletion of natural

resources and (2) pollution of the environment. Non-renewable resources cannot be used indefinitely as they will eventually run out. Even renewable resources, if used at a faster rate than they are being replaced, are bound to wear out. Against this backdrop, the production and disposal of large amounts of waste is seen by many to represent a short-sighted squandering of the earth's resources (Frankie et al, 1995, p. 3).

The major area of concern is pollution of the environment, which comprises the pollution of water by organic wastes, pollution of air through by-products of combustion, thermal pollution, and noise disturbance (Fuggle and Rubie, 1992). Just as raw materials are in finite supply, the environment is an only finite sink for pollutants; pollutants will eventually reach high concentrations and cause deterioration of environmental quality. This not only has ecological, but ultimately also economic implications. Improper or non-existent waste management is only one of the components contributing to environmental pollution, but certainly one of the most obvious, and one in which almost everybody may be personally involved. To zoom in on the South African situation in general and the scenario in the study area along the urban fringe of the Tshwane municipality in particular, the City of Tshwane Metropolitan Municipality (CTMM) is presently spending millions of Rand to clean up open spaces which are used as illegal dump areas by residents and building constructors (**Figure 3.3**).

According to the municipality by-laws, the government cleans illegal dump when the polluter could not be identified. If identified, the polluter is bound by law to remove the waste. The city by-laws however seem not to take into consideration, people who are staying in informal areas without waste collection services. It is easy to identify polluter in these areas because they dump in open spaces and along roads close to their homes. One could therefore deduce that the law enforcer is not doing anything about it because they could come up with alternatives for these people.

Refuse pollutes open spaces

Shaun Majoor

The city's green belts and open spaces are being choked by building rubble, refuse and garden refuse as many building contractors and city residents openly dump their rubbish illegally instead of driving to the sites allocated for dumping.

The Tshwane Metro's state of the environment report deals with among other issues, land pollution and waste management.

"The extent of land pollution which includes illegal dumping, overgrown sites and the presence of rodents, is measured by the total costs and number of complaints received relating to this matter," says Councillor Clive Napier of Ward 57,

spokesperson on land, housing and environmental management.

"The total cost to the municipality and ultimately the rate payer, for cleaning up polluted land amounted to a little over R27 million in the 2002 financial year. Some 29% of the complaints received by the municipality in 2002 were with regard to illegal dumping in open areas and on overgrown stands. Overgrown stands are usually vacant stands and an easy target for illegal dumping."

According to Metro by-laws, the Waste Management Section of the Metro removes illegally dumped material when polluters cannot be identified. In cases where the polluter can be identified, the polluter himself is to remove

the material.

Inspectors monitor illegal dumping and pollution in the city.

"A sum of approximately R27 million is a great deal of money for the city to be spending on land pollution.

"What is necessary, are tough new by-laws to ensure that polluters are brought to justice for illegal dumping and allowing open stands to become overgrown. By-laws are at present being drafted to curb these activities.

"Laws are desperately needed and it is hoped that they will be promulgated in the near future," says Cllr Napier.

The municipality operates 11 landfill-sites and a number of garden-refuse sites, which illegal land pol-

luters should be using instead.

These sites receive approximately 2.2 million cubic metres of waste per annum costing the ratepayer over R42 million a year to operate.

Some 46% of the waste deposited at these sites is generated by households, 32% is garden waste and despite massive growth in Centurion and the east of Pretoria only 14% building waste.

Only about 1% of the waste received at these sites is recycled.

"The recycling of waste is a job creator and if innovative ways could be found to identify and recycle more waste, more jobs can be created for the unemployed," says Cllr Napier.

Figure 3.3: Environmental pollution costs municipalities millions.
Source: Die Rekord Oos, 20/08/2004, p. 6.

Each type of waste has its own biological, chemical and physical composition, it poses its own particular problems, and different methods of treatment and disposal must be applied. Domestic waste is basically composed of three types:

1. **Bio-degradable waste** such as food left-overs. They take between two weeks and five months to be broken down by natural processes (Hugo, 2004), depending, of course, on temperature and moisture available. The Winterveld/ Pretoria situation on the Highveld with its relatively continental climate (see 4.2) would cause longer break-down times than, for instance, coastal KwaZulu-Natal with its much higher average temperatures and moisture.
2. **Combustible waste** such as plastic, rubber and artificial fibre. When these materials are exposed to ultra-violet rays of the sun, they take 10-30 years to break down. When they are buried, however, as is the case with most municipal landfills, their lifetime is practically infinite.

3. **Non-combustible waste**, e.g. metal food cans, is broken down by the normal processes of the weathering cycle, such as oxidation and weathering. Aluminium tins, for example, can take 80-100 years to break down, (**Table 3**).

Any form of waste is a potential threat to both human beings and the natural environment, whether controlled or not. Waste that is disposed of improperly can block drainages, leading to standing water that encourages breeding of mosquitoes and flies which in turn result in threat of diseases such as diarrhoea and malaria. Houseflies are attracted to rotting waste-food where they eat and deposit eggs. Uncollected waste emits bad odours, encouraging pest breeding, physical injury to children and animals.

The natural environment is affected adversely when uncollected waste is transferred into storm water channels, streams and rivers and eventually into the seas, affecting the quality of water and influencing detrimentally on the ecology of such areas. Decaying organic matter and bacteriological activity use oxygen, thereby reducing the amount of oxygen available for aquatic life, (Water Research Commission, 1995). The process of decay leads to the undesirable growth of aquatic weeds, algae and macrophytes, affecting water quality and aesthetic value of the area.

Solid domestic waste has a complex composition, ranging from biodegradable materials such as food waste and paper, hazardous waste such as cleaning detergents, paraffin, non-biodegradable materials such as glass, rubber aluminium cans and plastics. Apart from its immediate and direct health and environmental hazards, waste, especially hazardous waste disposal, could lead to a long-term contamination of the ambient air, soil, surface and ground waters. **Table 3** below shows some of materials found in domestic solid and the time it takes for them to degrade in the open environment.

Table 3: Waste types and their life spans

Product	Time needed to degrade in the open
Glass bottle	1 000, 000 years
Plastic six-pack holders	450 years
Aluminium can	200-400 years
Steel (tin) can	80-100 years
Rubber sole	50-80 years
Leather belt	40-50 years
Nylon fabric	30-40 years
Hard plastic container	20-30 years
Disposable diaper	10-20 years
Wooden stick	10-15 years
Cigarette butt	2-5 years
Hemp rope	1-14 months
Woollen cap	12 months
Cotton rag	1-5 months
Banana or orange peel	3-5 weeks
Paper	2-4 weeks
Source: Hill, M.K., 2004	

Waste dumps in Winterveld comprise all the above listed materials at different percentages, with the most dominant materials being food left-overs (represented by banana/orange peels) which take approx. five weeks to decompose, and glass bottles, plastic packaging, aluminium and steel cans, which would take up to 1 million years to disintegrate in the open system. From this analogy, it can be deduced that the some of the impacts of indiscriminate dumping of waste shall never be reversed.

The above-discussed environmental implications of waste lead us to the next topic of discussion that looks at the management of waste; especially management of domestic solid waste, as one of the tools used to control environmental pollution and degradation.

3.5 Solid Waste Management (SWM): Strategies and problems

3.5.1 Solid Waste Management approach

As the section on the changing approaches to waste management in history showed, over the past years and decades, numerous methods of pollution control were tested and made operational to reduce the stress on natural systems which otherwise would bring it close to the breaking point.

One of the methods to put pollution under control, is Solid Waste Management (SWM), but just like any other methods, it has its advantages and disadvantages, depending on how, where and who is carrying it out.

Management of solid waste is of great concern regarding the risks, both direct and indirect, and therefore the environmental impacts associated with waste disposal activities. The geographical locations of waste sites and facilities are of utmost importance, as they determine the extent to which health and natural environment will be affected. “If dumped indiscriminately in any environmental media, waste can result in contaminant releases, possible exposures, and potential adverse health and environmental impacts”, (Asante-Duah, 1993, p. 8). The effective management of waste has therefore become an important environmental priority and a growing challenge for further research. Due to the ever-increasing environmental problems, provision for pollution control and waste disposal must also continue to be improved.

An effective system for SWM must be both environmentally and economically sustainable. Environmentally sustainable means it must reduce as much as possible the environmental impacts of waste management, including energy consumption, pollution of land, air and water, and loss of amenity; economically sustainable means it must operate at a cost acceptable to the community, which includes private citizens, businesses and government. The cost of operating an effective solid waste system will depend on existing infrastructure, (Frankie *et al.*). It is practically difficult to achieve environmental and economic sustainability simultaneously, so the balance needs to be reached to reduce the overall environmental impacts of the waste management system as far as possible within an acceptable level of cost.

Waste management is a rapidly developing multi-disciplinary applied science and offers practical, effective and often innovative solutions to many modern waste problems, (Botha et al, 1992). The input of a team with a wide field of expertise is required in order to deal comprehensively with the many factors of waste management problems.

For centuries, Solid Waste Management (SWM) has consisted of nine basic steps: (1) Generation, (2) Collection, (3) Storage, (4) Transportation, (5) Recycling, (6) Reclamation, (7) Reduction, (8) Disposal, (9) Sale of recovered resources. Not all steps are necessarily engaged in one place, and not necessarily adopted in this order.

These stages can take place in a different order from the one outline. For example, waste can be recycled at source and sold from that point with the remaining waste being collected and

transported directly to disposal site. Hall (1989) in WRC Report No 629/1/96 points out that the “aim of waste management is essentially the responsible re-introduction of waste into the environment”.

3.5.2 Waste Management Strategies: problems to be considered

There is no universal solution for waste problems. Waste management for any area needs to be adapted to the local physical, cultural and economic circumstances (Water Research Commission, 1995). Climatic and seasonal variations as well as topographical and pedological characteristics are only some of the factors which must be taken into consideration when planning strategies for management of waste. Some places could be too wet for land filling of waste, or flooding / overflow from floodplains could occur, resulting in untreated wastewater runoff from the landfill into rivers and lakes. Budget limitations also have to be considered, a constraint which, of course, is very important especially in developing countries where the economy is too low to adapt high technology facilities.

Depending on the physical characteristics and environmental vulnerability, some waste management strategies might be suitable for one area but not for another. The selected strategy should not only be generally accepted by the managers, but by the community as well, in order to provide sustainability. It is therefore paramount to also consider social and even religious customs of an area when implementing new strategies.

The level of public health knowledge among the public should be tested before implementing a strategy in the area. If somehow the assessment by the manager shows that awareness and knowledge are insufficient, necessary measures have to be taken to bring increase the knowledge to a satisfactory level. A public which lacks knowledge might be more inclined to trespass e.g. into the landfill facility, in search for recyclable material, and thus unknowingly to put their health in danger, as, of course, not all types of waste are safe for re-use or recycling, even if they are just browsed in search for those that can be recycled.

Environmental standards differ from country to country and from company to company. It is therefore important to consider standards of the place where a strategy is about to be implemented. Enforcement of such standards should be assessed, as in some countries and/or areas, policies and environmental standards only exist on paper, but are not enforced by any legislation. This concern leads to another one, namely the quality of management itself, and availability of technical

skill to implement the strategy. There should be well-trained technicians who would maintain the place in the right conditions, also who are confident enough to intervene in times of crisis.

The formulation of waste management strategies should not be based on crisis management, although allowance must be made for this. Rather, it should be implemented on a logical and systematic discipline which has considered all appropriate bottlenecks, needs and alternatives. All sectors must co-operate in an informed and responsible way to arrive at the best practicable environmentally acceptable option for the disposal of any given waste.

3.6 Solid Waste Management (SWM) in South Africa

3.6.1 Development of waste management legislation in South Africa

In South Africa, public responsibility for the conservation of natural areas was established “only implicitly with the first proclamation of national parks and nature reserves by governments in the late 19th and early 20th century” (Fuggle and Rabbie, 1992).

During 1973, the solid waste legislative powers of provincial councils dealing mainly with the prohibition of littering and with refuse removal, was administered at local level (Fuggle and Rubbie, 1992). Legislation intensified later, resulting in the proclamation of the *Prohibition of the Dumping of Rubbish* (Ordinance 8 of 1976) in the Orange Free State (OFS) and the *Prevention of Environmental Pollution* (Ordinance 21 of 1981) in Natal.

At national level, a draft bill on the disposal of containers was published in 1977, but was not finalised or put into practice (Fuggle and Rubbie, 1992). Likewise, comprehensive draft regulations on solid waste control, published by virtue of the *Environmental Conservation Act of 1982 and 1989*, so far failed to come to fruition (Botha *et al*, p. 493). Littering and waste management are issues which have been addressed extensively in the Environmental Conservation Act 79 of 1989.

Today each sphere of government is tasked with promoting the awareness of every person in the country to ensure the knowledge that they have a vital role to play in managing their own waste. In the late 20th century, a whole range of laws which directly or indirectly refer to waste management exist in South Africa, the most important ones being:

- Constitution of the Republic of South Africa (Act 108 of 1996);
- Environmental Conservation Act (Act 73 of 1989);
- National Environmental Management Act (Act 107 of 1998);

- Health Act (Act 63 of 1977);
- National Water Act (Act 36 of 1998);
- Local Government: Municipal Structures Act (Act 117 of 1998);
- Occupational and Safety Act (Act 85 of 1993);
- Hazardous Substances Act (Act 15 of 1973);
- National Road Traffic Act (Act 93 of 1996);
- Municipal By-laws;
- Solid Waste By-laws; and
- White Paper on Integrated Pollution and Waste Management, (2000).

As can be seen from this extensive list, there is ample environmental legislation; however, as the investigated example of the Winterveld settlement shows, the enforcement of such laws and policies by government or municipality is still lacking. The Results & Discussion Chapter (Ch. 6) will critically evaluate the effectiveness of this legislative framework.

The authorities' approach to waste management in South Africa has also changed throughout the last decades. The traditional 'end-of-pipe' approach which focused on dealing with waste once it was produced is no longer adequate. Instead of concentrating on the storage, collection and disposal components of waste management system, more attention is been given to the avoidance of waste in the first place as a first priority [*Environmental Conservation Act, Act 73 of 1989, Section 24(d)*]. Only in the case when complete waste avoidance is impossible that we should look for ways to reduce, re-use or recycle [*Section 24(e) of the same act*] the unwanted material.

Following this new paradigm, in 2000, a national policy on pollution and waste management was published (*Integrated Pollution and Waste Management for South Africa, Notice No. 227 of 2000*). This policy mainly shifts the focus of waste management away from the disposal of waste to avoidance, reduction, re-use and recycling of waste, before any handling and final disposal could occur. It sets principles that which include accountability, cradle-to-grave responsibility, equity, integration, open information, polluter pays, subsidiary, waste avoidance and minimisation. Municipalities and industrialists, who are now taking responsibility to dispose of waste in an environmentally friendly way, have adopted this policy.

The CTMM published new by-laws on solid waste in their efforts to reduce the number of illegal dumping sites. These by-laws takes all categories of waste into account, including industrial waste , garden and domestic waste, builder's rubble, hazardous and medical waste, as well as littering and

dumping (Figure 3.1). In Figure 3.1, Councillor Napier of the CTMM welcomes the new by-laws and stresses that they should be "enforced vigorously and backed by suitable tariffs and penalties", (Die Rekord, 2005).



A new by-law on solid waste might reduce the number of dumping sites like this one. Councillor Clive Napier showed **Rekord** the sites in the Groenkloof Nature Reserve.

By-law cleans city

The Tshwane Metro accepted a new comprehensive by-law on the handling of solid waste in Tshwane.

Councillor Clive Napier, party spokesperson on land, housing and environmental management, says the law allows the Tshwane Metro to remove any waste or nuisance that affects the cleanliness of a property, including vegetation, shrubs or trees. The Metro may then charge the owner of the property with removal costs.

The councillor says that the

law also supports the possible recycling of waste and the potential for job creation in the process. The by-law takes all categories of waste into account, including industrial waste, garden and domestic waste, builders' waste, hazardous and medical waste, as well as littering and dumping.

Councillor Napier welcomes the by-law but he says it should be enforced vigorously and backed by suitable tariffs and penalties. He wants to see the private sector participating.

Figure 3.1: The new City of Tshwane by-laws, welcomed by Councillor Clive Napier
The reality of the optimistic heading "By-law cleans city" remains, however, yet to be seen.
Source: Die Rekord, 13/ 05/ 2005, p.5

There is a growing concern for the inadequacies of SWM in developing countries, and developing areas of countries of mixed economies", (Blight and Mbande, 1996). Even within one country, solid

waste collection systems are not automatically transferable from one community to another because of different standards of living and conditions as discussed in the previous section (Smith, 1997).

South Africa is classified as a developing country, with a wide range of economies (from rich communities to the poorest of the poor communities which live below the poverty line). Communities of small towns and rural areas of South Africa usually cannot afford to apply standards equal to those in the large cities; and also, the majority of them cannot afford to pay for refuse removal services. As a result, large quantities of waste produced in these areas remain uncontrolled and unmanaged.

“Three factors contributing to growth in domestic waste generation are increasing population, increasing urbanisation and an increase in the standard of living. Urban domestic waste generation in South Africa averages between 0.5 and 2kg per person per day”, (Bincheno, 1998). Urban areas or cities normally are fully serviced by municipality or private companies that are contracted by the municipality. Not surprisingly, many rural areas and especially the informal settlements which are sprouting all over South Africa lack basic services, among them domestic waste removal services. As the result, South Africa is at a complex state of waste management.

3.6.2 Waste collection choices and distances

The Department of Environmental Affairs and Tourism (DEAT) developed *Guidelines on Waste collection in High Density and Unserviced Areas*. During the development of these guidelines, workshops were held at a national and local level. Results were made published and made available for municipalities to use them extensively to make their waste systems more sustainable. The *Guidelines* deal with appropriate strategic placement of temporary storage facilities in unserviced are, and appropriate transportation from such storage to the landfill site.

The choice of an on-site storage system depends on a number of factors, such as the amount of waste and the accessibility of the storage area. There may also be a combination of systems in the area to suit particular requirements, e.g. a household in the informal area would store rubbish in plastic bags, while a shop would store its waste in a large container such as a skip.

The method of transporting waste from temporary storage to landfill site or transfer station depends on distance. **Table 4** summarises different transportation methods over specified distance.

Table 4: Transportation methods for domestic waste

Distance to landfill site	Appropriate transportation method
5000 metres	Wheel barrow
2km	Cart
5km	Tractor-trailer
15km	Closed truck
20-25km	Tip pack vehicle
30km	Mobile compactor vehicle
30-90km	Roll-on roll-off vehicle (for transporting skips)
Source: DEAT, n.d.	

In addition to collection and disposal of waste, certain activities are encouraged in order to keep the places clean. These activities include sweeping of the streets and picking of waste along the roads and public places, cleaning of open storm water drains and cutting of road verges and open spaces. Part of this study was to verify if these activities are indeed taking place in Winterveld (see Chapter 6).

3.6.3 The role of municipalities in waste management in South Africa

The municipality is bound by Municipal Systems Act to deliver waste collection services.

In delivering the service, role players are required to practice “*Batho Pele*” principles which aim at putting people first (DEAT, n.d.). The eight *Batho Pele* Principles are:

1. Consultation which binds the municipality to consult with residents about the level and quality of service.
2. Service standards: people should be informed what services they are entitled to receive and what options are available.
3. Access to services: The services must be equally available to all, including disadvantaged communities.
4. Courtesy: Treat everyone with consideration and respect.
5. Information: Always provide residents with full and accurate information about services they are entitled to receive.
6. Openness and transparency: Be honest and open about how municipalities are managed, the cost involved and who is in charge.

7. Redress: Respond to complaints speedily, apologise if you have not delivered a promised service, and offer an explanation.
8. Value for money: Eliminate wastage and always provide services that give the best value for money.

As the responses of the solid waste management contractors indicate (Chapter 6 and Appendix C), they seem to be aware of these principles and the need for cooperation. However, as these principles cannot legally be enforced, their implementation still depends on the goodwill of the key role players.

4. STUDY AREA

4.1 Socio-economic description of Winterveld

Winterveld is a peri-urban area located about 50km north of Pretoria, covering a total area of 120 km² (Simone, 1998, cited in Rogerson, 1999, p.526). The location of Winterveld in the north-western part of the CTMM, bordering the North West Province (NWP), is illustrated on the map in **Figure 4.1**. It is a partly formal, partly informal settlement which temporarily was under Bophutha-Tswana authority. It is "characterised by a well developed community system, where people travel daily/weekly for work between Pretoria and their homes", (Ferreira *et al*, 2004).

Informal settlement part of Winterveld is poverty-stricken, with hardly any formal infrastructure, and a low quality of housing, which only complies with the minimum standards (Ferreira *et al*, 2004). Only 20% of the population in the informal area have some form of formal employment (Rogerson, 1999). The majority of the population (80%) is unemployed; a large number of the formally unemployed are engaged in a range of informal economic activities within the area, such as motorcar repairs, spaza (informal) retailing, the manufacturing of burglar bars, shoe repairs and small-scale carpentry. These activities may already give a hint on the different waste types that are generated in the area, in addition to domestic refuse.

Winterveld is divided into five sections (**Figure 4.1**). According to the Tshwane Municipality, the older parts of Winterveld (Klippan – formerly Klippan North and Klippan South, Morgan – formerly 10 Morgan and 5 Morgan) are classified as "informal". The formal parts comprise the newly established sections of Lebanon, Beruti and Slovoville. The informal settlement parts, Klippan and Morgan, by far constitute the largest section of Winterveld (**Figure 4.1**).

The long-term immigrants come in search of jobs, in either the mines or industrial areas (e.g. Roslyn and Akasia) in the fringes of Pretoria City. **Figure 4.2** illustrates a population density map of CTMM. It shows a population density range from only 0-945 persons/ km² in the northern part of Winterveld, to the much higher density of 4381-8212 persons/ km² towards south, which is also towards Pretoria City and the densely populated industrial areas.

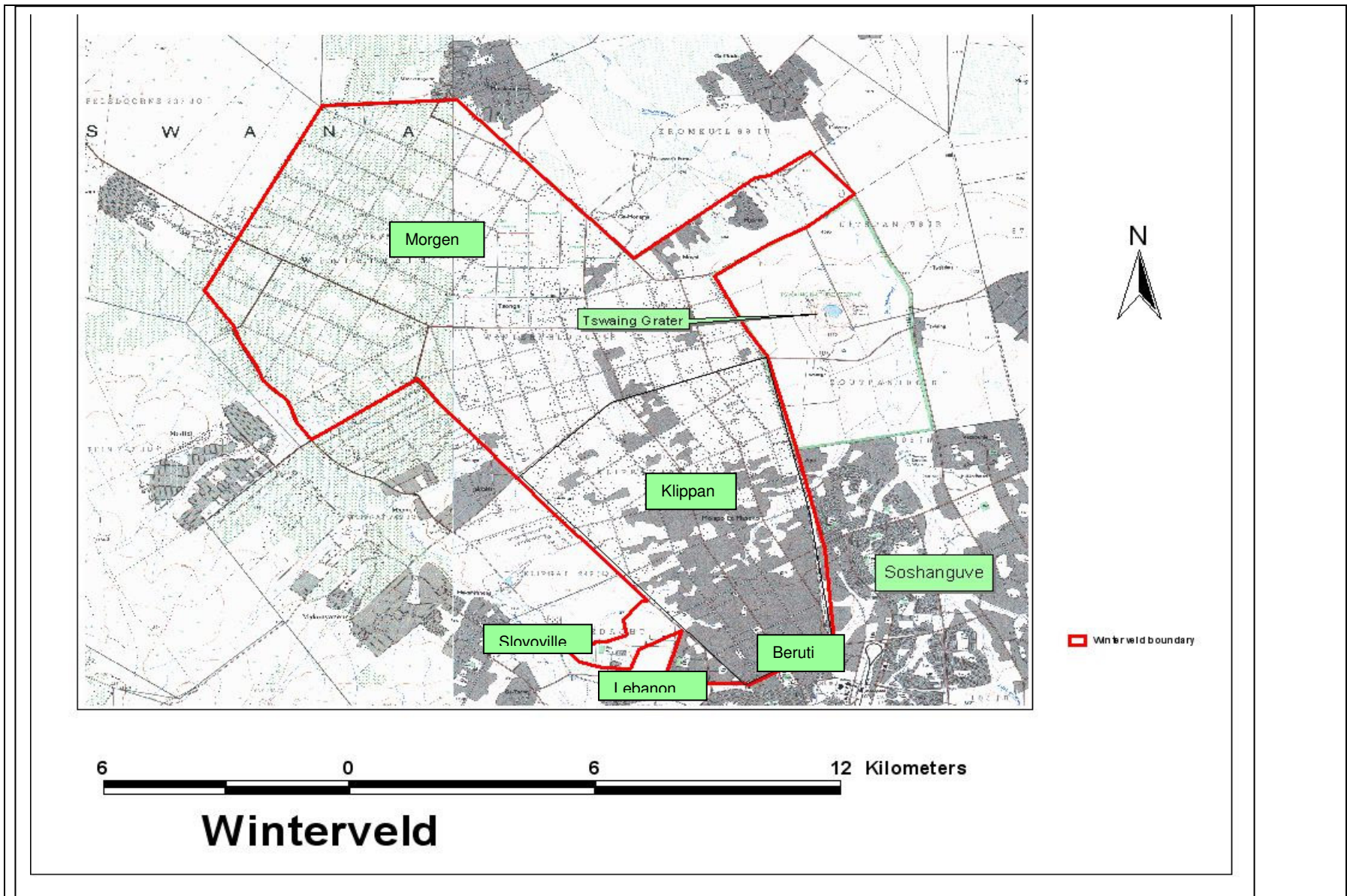


Figure 4.1: Location of Winterveld within the CTMM

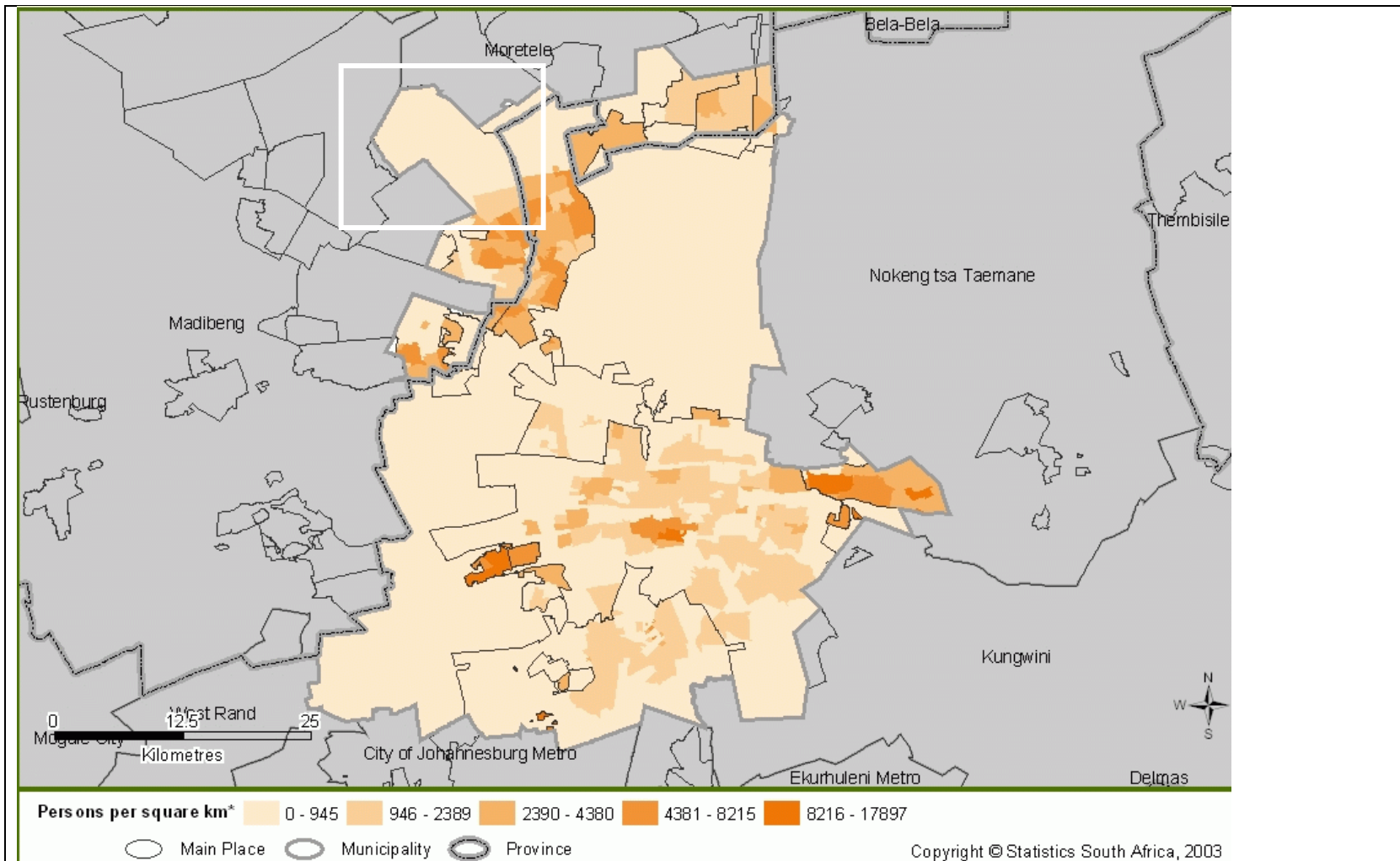


Figure 4.2: Population density map of the City of Tshwane Metropolitan Municipality.

The box marks the position of the Winterveld settlement, at the border of Gauteng and Northwest Province.

Source: Statistics South Africa, 2003.

This population pressure on Winterveld, both by rural-urban and cross-border migration has resulted in an increase of informal settlements and increase in population density in the area (Van den Berg, 1994). The study undertaken by the Department of Housing of the CTMM indicates an increase of 20,518 informal dwellings between 2001 and 2003, with Winterveld contributing 1,195 dwellings (Tshwane Open Space and Framework, 2005).

4.2 Physical environment of the Winterveld area

Geologically, the Winterveld area is part of the Bushveld Complex, which is dominated by a large variety of igneous rocks (Lurie, 1994). All of them have been chemically weathered in the geological past to form thick regoliths and soils. The soils in the area are dominated by yellowish-brown sandy loams with high base status and depth of >300mm. The area is well drained; erosion and deposition by wind and, mostly, water are responsible for the transportation of soils from one location to another. The topography is flat to slightly undulating, (North West Province, 2002, and Topographical Map, sheet 2528 AC). The thickness and weathering status of the soils unfortunately not only renders them very susceptible to erosion once exposed, but also facilitates infiltration and percolation of both, water and potentially hazardous substances found in waste dumps.

The climate of Winterveld is typical for tropical regions with summer rainfall, peaking in December. The mean annual precipitation is 500-600mm, but with a considerable inter-annual variation. The inter-annual variability of rainfall ranges from wet years (1159.4mm) to dry years with 405.1mm only (Thamae, 2003). Between 1960 and 2003, 23 years received below-average rainfall and only 18 years received above-average rainfall. Summer rainfall has increased at a higher rate than winter rainfall has decreased, resulting in an overall trend of a slight increase in total annual rainfall amounts (Thamae 2003). The existing hazards related to transport of illegally dumped waste by flash floods or sudden flooding of rivers will thus also have to be dealt with in the future.

Temperatures are characterised by great seasonal and daily variation; daily average maximum temperatures of 32°C are experienced in January while a daily average minimum temperature of 0.9°C is common in June. Days of average heavy frost range

between 1-30days per annum. Relative humidity is typically low and ranges from 28-30%. (North West Province, 2002). This climatic setting leads to a relatively high environmental variability, with the danger of soil being exposed by lack of vegetation, even by frost damage, and veld fires (especially during the dry season), and then becoming even more vulnerable to runoff, erosion and gully formation (Croucamp, 2004). Considering the existing poor waste management practices (see Chapter 6), it often can be observed that solid waste is spread all along gullies and riverbeds during times of flooding, causing even more environmental hazards.

The vegetation of Winterveld falls within Savanna Biome and arid sweet bushveld. Vegetation of this type is heterogeneous with veld type grasses and shrubs, (Acocks, 1988). However, the natural vegetation of Winterveld has been highly disturbed and degraded by settlement densification and trampling (Fisher, 2004), as well as the uncontrolled grazing of animals. Encroachment of alien and invasive species has replaced areas of natural vegetation, particularly in densely populated areas. Illegal waste dumps and other environmentally unfriendly practices result in the destruction of natural vegetation and provide an all-too-suitable habitat for alien and invasive species. **Table 5** (below) lists some of alien and invasive species occurring on the illegal waste dumps in Winterveld.

4.3 The state of Solid Waste Management in Winterveld

Despite the fact that the Winterveld population is increasing at an alarming rate, previous studies (e.g. Maluleke, 2002) reveal that in many parts of Winterveld waste management is almost non-existent. Management of waste in some areas without formal infrastructure is entirely the responsibility of the residents, who, however, lack knowledge and finances to do the job. It is not surprising, therefore, to see illegal waste dumps all around the area (**Figure 1**), especially in and around the informal settlements, where most problems are enhanced. The parts of Winterveld which do receive the delivery of formal waste management services include the more formal sections of Beirut, Slovoville and Lebanon.

Maluleke *et al.* (2003) report that in Winterveld removal contracts are in place with local people, but that these contracts are on a day-to-day basis only. A second set of contracts exist for the removal of waste from the sidewalks in the wider Winterveld area.

Regarding the final disposal part within waste management, Winterveld has tied in with the broader Tshwane regional planning, as it would not be feasible to develop and operate a landfill for the area on its own. Presently, the Winterveld waste is transported to a transfer station at Mabopane to be later transported to a permitted landfill.

A local group of people started a formal recycling project with funds from Department of Public Works. In 2002, this project was in its final stages of auditing, before it was to be approved as sustainable. Informal recycling was, like in most similar communities, carried out in the form of individual projects rather than as an integrated project which would maximize the benefit for the broader community (Maluleke *et al.* 2003). At present, there are no reports regarding existing recycling projects.

However, individuals are still recycling waste, especially at a landfill site (**Figure 4.3**), despite of all the potential health problems encountered during digging through the waste, sometimes not even with the minimal protective clothing.



Figure 4.3: Locals collecting recyclables from the Soshanguve landfill site.

Residents in the Winterveld, Soshanguve and Mabopane areas prefer landfill site recycling over household recycling. The waste disposed by the contractors is browsed and in parts recycled, and then covered by loose sediments (middle ground) which are, however, extremely prone to gully erosion.

Photo: IU Stengel, April 2004

4.4 Potential reasons for poor waste management in Winterveld

In functional terms, Winterveld is part of the Greater Tshwane Metropolitan Area, “albeit in constitutional terms the settlement is now a part of North West Province” (Rogerson, 1999, pp 526, after Simone, 1998). For this reason, it is expected that management of waste in this area be under the full mandate of the City of Tshwane Metropolitan Municipality (CTMM). However, not all of Winterveld is proclaimed as a town, and because of the undefined nature of the settlement (Maluleke *et al.*, 2003); the Metro finds it difficult to deliver accounts and to recover delivery costs from the informal residents. It is mainly for this reason that in the non-formal parts of Winterveld, similar to other urban fringe areas in South Africa, formal waste management is almost non-existing. As mentioned before, here it is the full responsibility of the residents to manage their own waste. The question is; do they have sufficient means, equipment, and knowledge to handle this responsibility?

People’s attitudes towards the national government have changed since the first democratic government was elected in 1994. Originally, there had been the widespread euphoric anticipation that people would receive free service delivery and housing as some sort of compensation for their disadvantaged past. It came as a sobering surprise to many that things did not change “overnight” as they had expected; they still had to work hard to earn their living and make ends meet, as during the apartheid days. People’s attitude, anticipation and behaviour towards waste management practices is no different from this general sentiment; it therefore does not come as a surprise that almost any person asked why there was littering in his area, would reply something along the lines of “The government is not doing anything to clean our streets”.

In the weeks before the 2004 April National Elections, a cleaner than normal situation was observed. This situation, however, deteriorated during the following months, see **Figure 1.1** (Oct 2004), as was found during the fieldwork.

The saying “trash attracts trash” may also be true for informal parts of Winterveld. There are shacks build with waste materials such as rusted corrugated iron sheets and plastics. This, but especially the debris and litter already deposited along the roads,

certainly does not discourage a passer-by from adding litter onto what already exist in abundance. The aesthetic value of the area is already clearly degraded.

The people's attitudes play an important part towards effective Waste Management. Unless people understand the conditions they are exposing themselves to, they cannot willingly involve themselves in managing waste. The attitude that "it is not in my backyard" is common in the informal settlement of South Africa, where people will dump waste on the street, just to get it away from their own yards. This attitude seems to be prevailing in Winterveld as well (see below), thus the reason why there is a pile of waste in front of almost every yard.

There also seems to be confusion as to who is responsible for waste management in Winterveld area. In the State of the Environment Report (SoER) for Tshwane, it is reported that The Department of Housing, Planning and Development of the Local Government are currently providing a refuse removal service in the formal sections of Temba, Winterveld, Ga-Rankuwa and Mabopane. "Private contractors are employed on a contract basis to render the services. The Department of Housing, Planning and Development is also responsible for the operation of Solid Waste Dump Site in Temba and Ga-Rankuwa, the latter is serving Mabopane, Ga-Rankuwa and the formal sections of Winterveld. These sites are registered and properly managed", (SoER for Tshwane).

The personal interview with Municipality personnel revealed that waste management in Winterveld is the responsibility of the CTMM, and that the private waste collectors are contracted by CTMM.

Maluleke (2002) reports that the Department of Public Works plays part in funding recycling projects in the area; "eight disposal waste sites operate in the CTMM, and the local authorities and private contractors are responsible for collection of household and industrial waste". He also reports that most households, apart from a few low-income neighbourhoods and informal settlements are serviced by regular weekly collection of refuse bags in mobile waste containers.

5. RESEARCH METHODOLOGY

Field work and data analysis were carried out between April 2004 (shortly before the 2004 National Elections) and April 2006 (just after the 2006 Local Elections, with their strong emphasis on service delivery. The methodologies presented below were selected to tackle the research objectives as identified in Chapter 1.

It is only recently that researchers have shown interest in Winterveld as their study area, although there have been a couple of studies undertaken by the Dept of Geography of the University of Pretoria (e.g. Van den Berg, 1994; Mashaba, 2003; Croucamp, 2004, Fisher, 2004). So far, however, the research focused on fields other than Waste Management, namely settlement densification and land use change (Van den Berg, 1994), community water supply (Mashaba, 2003) and land degradation (Croucamp, 2004; Fisher, 2004).

It is for this reason that for this study, most of the information about the current waste management situation in Winterveld had to be acquired through a broad own inventory, which comprised extensive field work, air photo analysis, field mapping, questionnaires, in-depth interviews, as will be elaborated in the following sections. Various graphics and GIS software packages as well as statistical methods were used, as shall be outlined in more detail in the respective sections below.

5.1 Acquisition of background information

The theoretical background information on historical, legal, regional aspects of waste management, internationally, nationally (South Africa) and locally (Winterveld) was acquired from scientific literature. Legal documents were interpreted with regard to their relevance on waste management, and grey literature such as municipal and consultants' reports analysed. Newspaper reports and internet documents provided additional current incentives.

Spatial background information was acquired from the digital and visual analysis of 1:10 000 Tshwane Municipality orthophotos (2003), including large-scale printouts of these and conventional aerial photographs to identify field sites, land use types, settlement structure and legal and illegal waste dumping sites during field work. Settlement patterns and land use are functions of the social, political and economical context in which they occur; and

they provide essential background information on the potential quantity and composition of waste produced from the area.

Furthermore, waste management strategies currently used effectively in other countries, as well as in other parts of South Africa, but not in Winterveld, were assessed, mainly from literature, and their suitability for Winterveld evaluated. Methods and waste management strategies which, although low-cost, would provide a considerable alleviation of environmental and health impacts, were deducted from the results and used for the recommendations stipulated in Chapter 7, depending on their suitability and affordability.

5.2 Inventory of waste management, reliability, and associated problems

An inventory study was conducted in order to identify the type and quantity of waste originating from different activities carried out in the area, including household refuse. This information was collected throughout several series of field surveys, as well as by questionnaires filled in by residents and contractors and interviews with the relevant authorities.

Additional information, on the quantity and classification of waste collected from different activities, e.g. from houses, agricultural and small business sites was acquired from the responsible authority, CTMM. The phase for waste collection statistics considered seasonal variations of waste production rates and management practices.

5.2.1 Interviews

An in-depth interview was conducted with Mr. Andre Beeslaar, Deputy Manager for Waste Collection and Removal of the CTMM (06/04/2005), which provided a wide range of valuable information (see Chapter 6). A. Beeslaar is also responsible for contracting out the waste collection services to private companies. The structure of Winterveld, i.e. which parts were formal and which informal, was also not always clearly identifiable on maps and aerial photographs; the differentiation between the different settlement types according to the Tshwane Municipality definitions was solved with input from A. Beeslaar.

Following the in-depth interview with A. Beeslaar, the other role players within, or on behalf of, the Tshwane Municipality were identified, including the companies contracted to collect waste in the Tshwane Municipality area.

5.2.2 Questionnaires for contractors and residents

In order to gain widespread information on all components of waste management, i.e. the service provided, service efficiency, service perception, recycling practices, environmental aspects and hazard awareness, all role players had to be included in the analysis. Specific questionnaires were designed for the waste management contractors as well as for the residents of the formal and informal settlements in Winterveld and Morula View, respectively.

A total of 17 contractors, i.e. every single company which collects waste in Winterveld and the surrounding townships; namely Soshanguve, Mabopane and Temba, were included in the **Contractor Questionnaire** survey. These questionnaires were compiled in order to gain insight information into the waste collection operations, the strengths and weaknesses, problems encountered by contractors and their views on how the problems could be resolved. The Contractors' Questionnaire is attached as **Appendix A**, with samples of answered questionnaires in **Appendix C**.

Environmental and operational Laws, Standards and Regulations under which the contractors work were assessed through the questionnaire; whether they were realistic and practical or too relaxed for waste collectors to work under. All questionnaires were delivered personally to ensure that they would reach the destined contractors and that the relevant person would answer the questions.

The **Residents Questionnaire** was used to examine attitudes, behaviours, and knowledge and satisfaction levels of residents concerning waste management services by the CTMM, as well as practices of fellow residents. Questionnaire analysis applied qualitative and quantitative techniques to obtain the data presented and discussed in Chapter 6. A total of 240 questionnaires were administered; 113 of which were administered to the residents in the formal part of Winterveld, 88 to the residents in the informal part of Winterveld, and 39 to the residents of Morula View. The Residents Questionnaire is attached as **Appendix B**.

The separation of the two different settlement patterns in Winterveld was necessary due to the observation that the formal parts receive waste removal services while the informal parts are neglected thus far. Morula View was used as a standard (control area) for waste management practices, as it is fully serviced as far as municipal services are concerned.

Morula View is a relatively new suburb with modern style houses, and the collection services were perceived to be as good and reliable as in any other high-income suburb.

This residents' questionnaire analysis therefore also comprises a spatial component: it was undertaken to compare the collection services in the formal parts of Winterveld, which are supposed to be as good as those in any other formal settlement in South Africa, with another one of those settlements. The household selection and sampling methods used were the same as in Winterveld.

The residents' questionnaires were administered to the residents by seven post-graduate students from the University of Pretoria. The interviewees were mainly women of 20 years and above in each sampled household. Due to low level of education in the area, translation to other languages was necessary in some of the households. The sampling method for the households questioned was Random Systematic Sampling (RSS), which is more representative than Random Sampling. In the sampling method, a street map supplemented by the high-resolution orthophotos was used to demarcate the five sections of Winterveld (Slovoville, Lebanon, Beruti, Morgan and Klippan). An even distribution of houses was sampled using street map and aerial photos to identify the spatial pattern of survey. However, this method could not be carried out as planned, because most pre-selected households were either not attended or left in the care of children who could not respond to the questionnaires. Substitute nearby households had then to be selected instead.

5.2.3 Field work, mapping and digital analysis

The location of waste facilities is an important component of the waste management process as inappropriate location of waste facilities can lead to environmental damages, social and political conflicts and economic inefficiency due to misuse of such facilities. Geographical Information Systems play an important part in this regard as it gives a straightforward embodiment of the absolute view of space.

A preliminary field survey was conducted in April 2004 as a spatial reconnaissance study of the area, its settlement patterns, visually identifiable waste management problems, day-to-day activities of people, and the location of waste management facilities. High resolution colour orthophotos of 0.16 x 0.16 m pixel size (Tshwane Municipality, April 2003), were

blown up to scales of 1:10 000 and larger and printed for field work; in addition and enlarged topographic and cadastral maps were used for this purpose.

From the high-resolution orthophotos and the ground check on site, illegal dumpsites and littering debris along the roads were identified, and their distance from residence and formal landfill sites measured. The changing size and density of illegal dumping sites with the decreasing population density in the informal parts of Winterveld was recorded and analysed.

The digital version of the orthophotos, analysed with MrSid and ArcView, was used as a background layer for producing the digital overlays of dumping sites and dustbin spacing as presented in Chapter 6.

Day-to-day activities of people that might influence the composition and quantity of waste were noted; they included economical and subsistence activities, leisure, recreation, and sporting activities. The type of waste produced was noted as well as different disposal methods that residents used from different parts of Winterveld. Other factors that might be contributing to poor waste management were noted. Possible impacts of poor management noted, e.g., flooding, diseases, breeding of pests, injury to people and animals, pollution of water bodies were also observed. The findings of the fieldwork are discussed in the next chapter.

5.2.4 Waste stream analysis

In the informal parts of Winterveld, waste was traced from its point of generation to the point of final disposal, which in an informal settlement, typically and unfortunately, does not involve large distances. Waste stream analysis included the following stages: waste generation, storage, collection, transportation, and recovery/recycling. A semi-quantitative analysis of waste amounts was conducted, as well as a survey of the waste composition. At each stage of the waste stream, the environmental impacts were identified and recorded.

5.2.5 Evaluation of the effectiveness and suitability of facilities

The effectiveness and suitability of waste management services for Winterveld was evaluated by assessing its compliance with legal requirements as set out in Section

3.6.2. To that end, recorded visual observation together with information gathered from municipality personnel, contractors and residents was used. Discrepancies between policies and the present scenario in Winterveld were identified in order to provide a basis for recommendations of appropriate corrective measures (Chapter 7).

5.3 Problems encountered during the survey

Despite numerous efforts to gain a full comprehensive survey, there was a very low level of co-operation from the contractors. Only six out of seventeen contractors responded and returned the questionnaires. The Deputy Manager for Waste Collection and Removal Department of CTMM, intervened and requested, in his capacity as the officer who contracts them, that the contractors fill and return the questionnaires, but even that proved to be unsuccessful.

In Winterveld, the absence of some residents from their houses during the survey interfered with the sampling method which had been selected to ensure the statistically sound and spatially even distribution of the questionnaires.

Furthermore, safety issues also impacted negatively on the field study. During the second week of administering the questionnaires to the residents, a cash-in-transit high jacking incident, including shooting, was witnessed. The incident occurred a stone-throw from where the student's vehicle was parked. This experience added to the perception that Winterveld is an "open-day" high crime area. As a result, only 240 questionnaires could be administered as opposed to the initially planned 400 questionnaires.

One of the objectives of this study was to quantify the average weight of waste produced by each household in the area. This objective was not achieved because the university did not have a portable weighing scale with hooks which could be used to measure 5kg- 20kg of the anticipated household waste per week, and at a sufficiently high accuracy of 0.2 kg or better. Volume estimates were then chosen as a substitute.

6. RESULTS AND DISCUSSION

This chapter presents and discusses the wide range of research results. Each of the research objectives stipulated in Chapter 1 will be addressed by the findings.

6.1 The authorities and their role in waste management in Winterveld

Various authors and reports indicate that different authorities such as Department of Housing, CTMM and DWAF are responsible for waste management in Winterveld. All of these authorities were contacted and they all pointed to CTMM as the sole authority which is responsible for management of domestic waste in the Winterveld area.

Having identified the responsible authority, an interview was initiated with Deputy Manager for Waste collection and Removal department of the CTMM, Mr. Beeslaar. Until 2001, no services had been rendered to the some formal settlements of Winterveld. Even today (2006), informal settlements do not receive any services. The reason for that is the nature of the dwellings: residents do not have title deeds; it therefore is impossible for CTMM to recover the costs of service delivery (Beeslaar, pers. communication, 06/04/2005).

A number of municipal efforts were identified, either through observation of changing situations on site in Winterveld, during the two years of the study, by mapping and digital analysis, or through answers and concerns brought up by the residents themselves. The different initiatives are presented more detail below:

- The results of the waste bin campaign as initiated by CTMM is discussed in Chapter 6.3.1 and 6.3.2 below.
- For the informal parts, the problem of waste skips in the informal settlements is discussed in Chapter 6.4.1., and the problem of community participation is discussed in Chapter 6.4.2.
- For the formal parts of the settlement, municipal efforts of waste management are presented in Chapter 6.4.4.

6.2 Qualitative and quantitative survey of domestic waste produced in Winterveld

As stipulated in the objectives, an important task of this study was to obtain the average quantity of waste produced by each household in the formal settlements of Winterveld and in Morula View and to identify composition of the waste. This would have been the first (at least semi-)quantitative information ever gathered on this issue. The original intention was to measure or weigh the amount, and identify and quantify the composition, of the weekly produced waste from the same households as covered by the questionnaires.

This plan, however, had to be modified to some extent, during the course of the study. In order to quantify the mass of waste on site, a portable weighing scale with hooks would have been necessary with a capacity of at least 10 kg, and, at the same time, a sufficient measuring accuracy; however, the University of Pretoria did not have such equipment. Normal bathroom scales would not have been able to weigh the odd-shaped and bulky bags, and would not have provided sufficient accuracy. However, literature sources estimate between 0.5 kg and 2 kg of waste/ person/ day in South Africa (Bincheno, 1998).

To overcome this methodological shortcoming, a different method was employed to be able determine the quantity of waste produced by each household, namely to use volume estimates. This was achieved by including the number of refuse bags in the residents' questionnaire. Households in the formal Winterveld and Morula View settlements responded that they fill between one and two 85-litre plastic refuse bags per week (cf. Appendix B, Question B2). Sixty-five percent fill up one bag per week and 30% use two bags, while the 5% do not use any bags at all.

For additional information, a respective question was included in the contractors' questionnaire as well. Two contractors reported that they collected more waste on the last week of the month than any other time month (cf. Appendix A, Question B10), but could not quantify the difference.

So, while due to the highly variable composition of domestic waste and lack of portable equipment *weight* estimates were not possible, the *volume*, e.g. 85 or 170 litres per

household and week, gives an even better indication of the enormous quantities of waste which originate from a densely populated settlement each week.

The second goal, to identify the different component of the domestic waste, was achieved successfully and easily, especially in the informal settlements where waste is dumped on open spaces. The following components were identified:

- waste food including bones,
- plastic packaging,
- food and beverage cans,
- glass,
- paper,
- clothing material
- garden refuse,
- and in some dumpsites, dead animals.

As **Table 3** (above) showed, some materials (e.g. glass bottles) take up to one million years to disintegrate in an open environment, while paper and waste food decompose within the much shorter period of approx. five weeks only. Without outside initiatives or clearing action, the amounts of non-decaying waste materials accumulating at dumpsites thus are continually increasing. A particular hazard originates from the large quantities of broken glass dumped along roads and walkways; while bottles and cans could potentially be retrieved and recycled, broken glass cannot ever be removed completely.

6.3 Environmental problems resulting from poor waste management in Winterveld

The generation and disposal of waste were identified as the two dominant steps in the waste management stream in the informal part of Winterveld.

At first glance, the environmental impacts of these two steps seem to be localised only, by affecting just the immediate surrounding of the place of waste generation. However, during the field work over the various seasons, it was established that during summer highveld storms there is a considerable hazard of stormwater runoff transporting some substances over larger distances, e.g. from waste dumps into the adjacent streams and into the groundwater. This, of course, severely affects the environment even outside the

Winterveld border. Apart from fluvial processes, the wind also disperses smoke from burning trash, contributing to air pollution and other indirect impacts.

These two problems pertaining to the scale, dimension and spatial implications of waste redistribution by fluvial and Aeolian processes are not easy for residents to identify. It takes a higher level of education to understand issues such as geomorphic processes and soil vulnerability. Thus, to a non-professional, the spatial extent of negative impacts of waste mismanagement are not fully obvious.

It is even more difficult to understand indirect and potentially long-term negative consequences, such as ground water pollution and air pollution. Further research is recommended to investigate both direct and indirect impacts waste to ground and surface water as well as to the air. Maybe even more importantly, these impacts must be communicated to the respective residents at a suitable level of understanding.

The following paragraphs address problems observed during fieldwork as well as those identified by the residents during the interviews; these aspects are regarded as the most obvious problems.

6.3.1 Littering, illegal dumping and waste bins

A field survey was conducted in January 2005 during which illegal waste dumps in Winterveld were digitised and digitally overlaid on enlarged copies of the orthophoto mosaic. Only the large waste dumps occurring along the roads were included in the digital overlay; the literally innumerable small pits in the household backyards and the general littering along the roads are excluded. The waste dumps are presented in a green colour on **Figures 6.1 and 6.2 abc**. Waste bins are recorded with red dots on the digital overlay.

Figure 6.1 is attached in A3 format in Appendix D. **Figures 6.2 abc** are the enlargements of the Sections A, B, and C indicated by the boxes on **Figure 6.1**.

The digital survey also recorded the street waste bins which had been placed along the Winterveld Road, but only over a short distance of about 500m (**Figure 6.1**, and enlarged sections in **Figures 6.2 abc**). The bins aim to control littering, although

roadside littering only constitutes a small part of the much bigger problem “illegal dumping of household solid waste”.

The overall density of the illegal waste dumps and placements of street waste bins over the entire surveyed area is illustrated in **Figure 6.1**.

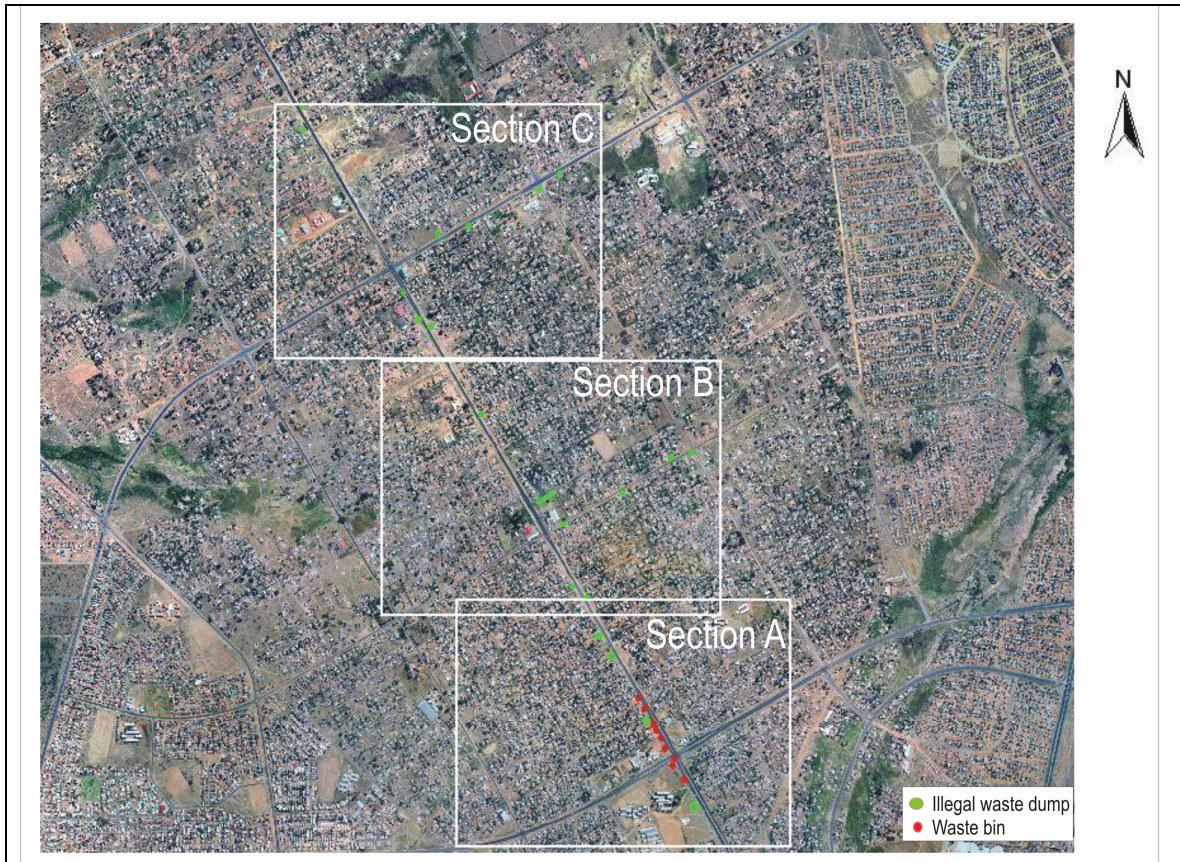


Figure 6.1: Orthophoto overview with digitized illegal waste dumps and dustbins along the roads in Winterveld.

Aerial photo with digitized layer of waste dumps along main Winterveld Road. Waste bins are only provided on side of the road and only over a distance of 500m. Dumping of household waste occurs around these bins since they are not big enough to hold larger quantities. Sections A, B, C are presented in enlarged format in Figures 6.2a, 6.2b, and 6.2c, respectively.

Mapping: January 2005. **Background source:** Orthophoto mosaic from Tshwane Municipality photographs (2003). Orthophoto sheet 2528AC 17.

The results of the digital and field analysis (**Figures 6.1 and 6.2 abc**) reveal a shocking, but nevertheless typical, scenario whereby households typically dump waste as far as is practically safe from their yards. Litter and waste dispersed by wind and water also accompany the illegal dumps and affect an even bigger space. During the wet season, the ditches which had been blocked and clogged with waste in the dry season fill with

water. As this water either spills over or infiltrates into the ground, it transports solubles and solid matter, thus polluting sub-soil, ground water and the adjacent areas.

The biggest waste dumps are found in open spaces and ditches among the densely populated parts (Section A, **Figures 6.1 and 6.2a**) and get fewer and smaller towards the sparsely populated parts (Section C, **Figures 6.1 and 6.2c**).

The southern, more densely populated part of Winterveld Road (Section A, **Figure 6.2a**) was provided with more waste bins than the central and northern parts. While there are fewer illegal dumping sites than further north, still a lot of dumping was identified, sometimes even right next to the existing waste bins. Overall, however, the smaller number of illegal waste dumps on **Figure 6.2a** seems to correlate with the higher number and dense spacing of waste bins.



Figure 6.2a: Enlarged section A, southern part: most waste bins.

A digital layer of waste bins (red) and illegal waste dumps (green) along the main Winterveld road reveals the reality of waste disposal problems in informal settlements. In spite of densely spaced waste bins, there is still a lot of illegal dumping, sometimes even next to the waste bins. Waste dumps in the backyards were not included in the digitised layer.

Mapping: January 2005. **Background source:** Orthophoto mosaic from Tshwane Municipality photographs (2003). Orthophoto sheet 2528AC 17.

As one moves further north, there are less waste bins and more waste dumps, see Section B (**Figure 6.2b**). The total lack of waste bin might be the reason for the extended illegal dumping sites, directly next to the road.



Figure 6.2b: Enlarged section B, central part. More illegal waste dumping.

Illegal waste dumping sites are marked in green, waste bins next to the road in red. The lack of waste bins in this section seem to be the cause for even more and larger illegal waste dumps.

Mapping: January 2005. **Background source:** Orthophoto mosaic from Tshwane Municipality photographs (2003). Orthophoto sheet 2528AC 17.

Finally, **Figure 6.2c** (Section C, further to the north) shows somewhat fewer waste dumpsites than the southern and especially the central parts, even though in Section C there were no waste bins recorded at all. This seemingly smaller waste problem can probably be attributed to the sparser population density towards northern Winterveld, which consists of scattered clusters of households with larger spaces in between.

Still, these less densely populated areas like in Section C should not be excluded from waste management systems and waste bin placement, as if their problem seems insignificant compared to the southern parts. They should be supplied with waste bins, firstly because "every little bit of litter counts", and secondly, because with the still ongoing growing densification process towards the north (see Chapter 4.1), the present not-too-pressing situation might soon become a more desperate one.



Figure 6.2c: Enlarged section C, northern part. Fewer illegal dumping sites.

Illegal dumping sites were digitized in green. As compared to Section B, there is an overall smaller number of illegal dumpsites, even though there were no waste bins provided by the municipality. This section of Winterveld is, however, less densely built-up and populated, following the overall decreasing density towards the north of the settlement (cf. Van den Berg, 1994).

Mapping: January 2005. **Background source:** Orthophoto mosaic from Tshwane Municipality photographs (2003). Orthophoto sheet 2528AC 17.

6.3.2 Problems related to municipal efforts

The results from the mapping entail a number of problems which all are related to the waste bins.

Firstly, waste bins are emptied once per week (Beeslaar, 06/04/2005) and relatively small. With their capacity of approx. 20 litres, they are only just big enough to hold, at most, the waste from one household for a week. To be efficient, the number of waste bins would have to match the number of household, which clearly is not the case. Some households have thus resolved to dump their waste next to these bins, as indicated in **Figure 6.3** (below) Still, the smaller quantities of litter and the lower number of illegal dump sites in Section A (**Figure 6.2a**) show that at least some people are indeed using the bins provided.

Secondly, the mapping (**Fig. 6.2a**) also revealed that the bins had only been placed on one side of the main Winterveld Road, and only over a total distance of 500m, mostly in Section A. They thus only service a small portion of the roads in Winterveld. In addition, Winterveld Road is one of the busiest roads and main traffic axis of the whole settlement, and the continuous traffic flow indeed poses a major obstacle for crossing the road for anyone who intends to use the waste bins.

A third problem is created by the type of waste bins themselves. The solid waste in informal Winterveld comprises, among other materials, ash and soil particles. The waste bins provided are made of meshed wire or metal, to provide air circulation and prevent organic material from rotting. This, however, renders them unsuitable for small particles of any origin. Those fine particles fall out, cannot be retrieved during collection, of course, and eventually start piling up around these waste bins.

It is therefore crucial that the composition of waste in an area be investigated before management strategies and facilities are introduced. As a next step, the facilities, their handling, utilization, and all related responsibilities need to be formally introduced to the residents. The present design of the street waste bins is definitely not meant for holding larger volumes of household waste; yet the residents seem not to recognise this.

Overall, it is not surprising that the waste bins clearly are not sufficient to prevent illegal dumping, even directly next to them (**Figure 6.3**).



Figure 6.3: Waste dumped around waste bins.

The photo, taken in April 2006, shows the effort of the municipality to alleviate littering in informal Winterveld. The effort alleviates some of the littering problems, but not the main issue of insufficient household waste disposal. Residents therefore dump their household waste around these bins which are not big enough to contain bigger quantities and different types of waste. In this example, sand and rubble contribute a large percentage of the dumped, but as the bins are made from meshed metal, they cannot accommodate soil or finer particles of waste.

Photo: LR Moiloa, April 2006.

The Tshwane Municipality was consulted on 06/04/2005 to determine the authority responsible for initiating the placement of street waste bins in the area. According to A. Beeslaar (pers. comm., 06/04/2005), the placement of street bins and "No dumping" signs were initiatives by the municipality to control littering in the area. However, within two weeks of this initiative, half of the signs had already been destroyed by the residents.

Hence, the waste bin campaign, sadly, must be recorded as yet another effort which was misused by the community. This followed the previous attempt by the municipality to place skips in unserviced areas, so that unserviced settlements residents were

supposed to dispose their household waste instead of dumping. This disrespect of municipality efforts by residents is another crucial issue which needs to be thoroughly investigated.

More evidence of disrespect was observed during fieldwork where “No dumping” signs had creatively, or desperately, been changed into “More dumping” (**Figure 6.4.**)



Figure 6.4: Disrespect for municipality efforts to keep Winterveld clean

The authorities' efforts might all be ineffective if the people from the community are unwilling to cooperate. Defiant action, like the one demonstrated in the picture either reflects the residents' negative attitudes towards municipal waste management initiatives, and/or the fact that they do not perceive, or hope for, any improvement.

Photo: LR Moiloa, April 2006.

Even though some residents are reacting negatively towards the initiative, the overall results observed are positive, the evidence is the reduction in dumping and littering in the vicinity of the no-dumping signs (**Figure 6.4** and **6.5**). To encourage the whole community to support the initiatives involves exhaustive information dissemination and awareness raising, but in the long-run, the results will come out positive for the benefit of all concerned and involved parties.



Figure 6.5: Signs warning residents and passer-bys against littering.

Setswana text reads: "No dumping next to the Church".

A small initiative like the one demonstrated in the picture has resulted in a notable positive change regarding waste dumping and littering. It is however necessary to provide the residents with alternatives, for an example an alternative to littering has been provided by placing waste bins on the street (see **Figure 6.3**). An alternative to dumping household waste must also be provided.

Photo: LR Moiloa, April 2006

6.3.3 Invasion of weeds and related hazards

Another important finding was the fact that the illegal waste dumping sites are largely overgrown, mostly by invasive weeds, with a number of serious consequences. The occurrence of weeds is common in disturbed places and thus also affects places where waste is allowed to pile up.

Figure 6.6a shows a typical example of alien and invasive weeds growing abundantly on, and sometimes fully covering and masking (**Figure 6.6b**), illegal dumpsites of Winterveld.



Figure 6.6a: Invasion of weeds on dumpsites.

The height, density and species composition of the weed cover depends on a number of variables, especially the amount of rainfall received during the present or previous rainy season. Although masking the dumpsites and thereby alleviating the negative optical impact, the weeds present a huge problem with regard to identifying illegal dumping from the air, even with the high-resolution orthophotos used, with their pixel size of 0.16 cm. **Photo:** IU Stengel, April 2004.



Figure 6.6b: The respective site from the air.

If it was not for the dark green colour of the tall weeds, the dumpsite would not be visible from the air at all. Only the detailed field knowledge and ground check survey, combined with geo-botanical understanding, provides a spatial indication of the size and position of illegal dumpsites as evident on aerial photographs. **Source:** Section of orthophoto 2528AC.

During field surveys at different seasons, five very abundant plant species were identified at the illegal dumpsites. The plant species and their brief descriptions are listed in **Table 5** (below). The plant species include the Castor Oil Plant (*Ricinus communis*). Castor Oil Plant is extremely toxic to humans and animals; even one single seed can potentially be fatal. Castor oil has to go through extensive purification process before it is safe for consumption (Kleynhans, 2001). **Figure 6.6a** (above) and **Figure 6.7** (below) illustrate the dangers emanating from those weeds, as the overgrown dump sites are regularly browsed and scavenged by pigs, goats, and sometimes, of course, people.

Tree Mallow (*Laterata arborea*) is another weed which was frequently found on the dumpsites. The plants associate with waste dumps, especially along the roads, obstruct vision and are generally unsightly (Kleynhans, 2001). Many of the weeds presently invading the whole of South Africa are regarded as aggressive alien species and should be removed as soon as they are observed. Their abundance on the illegal dumpsites is a potentially huge long-term ecological problem, which so far has not been addressed in waste-related studies at all.

Table 5: Plant species found on illegal dumpsites in Winterveld

SCIENTIFIC NAME	COMMON NAME	DESCRIPTION
<i>Argemone mexicana</i>	Yellow Flowered Mexican Poppy	Weed commonly found on cleared sites and new dam walls. Suspected to be poisonous to humans. Contaminate sheep's wool.
<i>Gomphocarpus fruticosus</i>		Indigenous plant which has become a weed in South Africa Occurs all over South Africa on disturbed sites.
<i>Catharanthus roseus</i>	Periwinkle	Used as a treatment for diabetes, insect bites, and pain. Found at roadsides and other disturbed areas, particularly in Mpumalanga and KwaZulu-Natal.
<i>Ricinus communis</i>	Castor Oil Plant	A common weed found in waste places, roadsides and river banks. Seeds are extremely toxic to humans and animals. It occurs throughout South Africa.
<i>Lavatera arborea</i>	Tree Mallow	Weed found in waste areas, sand on dunes and along roadsides.

Sources: Field work 2004-2005, and Kleynhans (2001).

6.3.4 Pests, diseases and injuries

Indiscriminately dumped waste also results in a range of cumulative problems. Some of these problems and hazards were visually observed during field work, whereas information on most others was obtained from the residents through questionnaires.

The easily observable problems were the ubiquitous presence of disease vectors such as houseflies, mosquitoes and cockroaches, which transmit diseases such as diarrhoea, malaria, etc. Rodents were also occasionally observed, and they are, of course, notorious for inhabiting homes, spreading fleas and associated diseases, and destroying property and crops.

Large mammals such as cattle, goats (**Figure 1.1**) and pigs (**Figure 6.7**) were also observed grazing on the dumped waste food and grazing on the plants that grow around them. Due to their close contact with humans, there lies a potentially huge hazard for the spreading of parasites. The droppings from those animals are not only unsightly and smelly, but add considerably to the overall health risk.

Domestic waste is composed of a variety of products, some of which can injure people and animals. Some products can even kill animals if swallowed, in addition to the hazardous and even toxic weeds (see 6.3.3).

As illustrated in **Figure 1.1 and Figure 6.7**, pigs and goats directly feed on the waste food on the dumpsites. In Winterveld, 27% of the people (66 out of 240 residents) reported they had heard, at least once per month, of animals having died from eating plastics, metals or toxic substances from waste dumps. As pigs, goats and cattle in Winterveld are allowed to graze on open spaces without fences or herd boys; and as those open spaces are the preferred areas for illegal dumping, the risk of dumpsite poisoning is even more pronounced.



Figure 6.7: Free-roaming pigs scavenge illegal waste dumps on a regular basis.

Animals are exposed to injuries and poisoning as they scavenge illegal dumpsites. The animals clear away some of the waste, but leave behind droppings, which are not only unsightly and smelly, but also a potential source of parasites. Sites such as these typically induce more littering and illegal dumping, and the saying “trash attracts trash” is surely applicable in such cases.

Photo: IU Stengel, April 2004.

Another 40% of the respondents reported that children occasionally suffer injuries such as a bottle and tin cuts from littered waste during play. Winterveld has been identified, by the Tshwane 2020 Integrated Development Plan, as one of the areas lacking in tourism development, parks, and recreational facilities. Many open spaces found in Winterveld are not developed, and therefore used for illegal and often mutually contradicting purposes such as grazing and dumping. Moreover, because of lack of recreational facilities and spaces, children use these unhealthy and unsafe areas as their only playgrounds.

6.3.5 Perception of problems related to poor solid waste management

Problems mentioned by the respondents are summarised in **Table 6**. The responses differ from place to place, probably due to the different methods of waste management in which individuals engage.

Even though some of these problems were identified and/or experienced and/or mentioned by a small percentage of respondents only, the fact that said problems exist is already worth mentioning, in order to be able to tackle them before they become major issues of concern.

Table 6: Problems caused by poor waste management, as perceived by residents

PROBLEM IDENTIFIED	PERCENTAGE OF RESPONDENTS WHO IDENTIFIED THE PROBLEM		
	Informal Winterveld	Formal Winterveld	Morula View
Smell	83	71	64
Water pollution	0	27	15
Air pollution	83	73	56
Aesthetics	83	73	56
Land pollution	0	1	0
View obstruction by flying plastics	0	4	0
Injury to people	61	60	60
Poisoning of animals	79	66	76
Diseases	33	90	54
Pests	14	3	0

Data source: Questionnaire results.

An overwhelming percentage of respondents (83%) from the informal part of Winterveld voiced their main concerns the smell from the rotting litter and smoke from neighbours' burning waste dumps. Smoke and ash particles soiling clothes and laundry and the long-lasting smell even after the rubbish had burned out were perceived as particularly unpleasant. Even according to the residents' own opinion, the aesthetic impression of the area could not be worse, but they argued that they did not have alternatives for littering and illegal dumping, due to the lack of service delivery and the large distances from their homes to legal dumping points and landfill sites.

An equally high percentage (83%) of the respondents identified the degradation in aesthetic value of the area as a major problem associated with the poor waste management in Winterveld (see the typical examples from **Figures 1.1, 6.6 and 6.7**).

To mention but one ramification of the degraded aesthetic value, Tswaing Crater, a 200.000 year old, clearly visible meteorite impact site (**Figure 4.1**), a major attraction for geoscientists and tourists alike, is located just outside and to the northeast of Winterveld. Any visitor is thus required to drive along some of the roads described above. The same is true for the Ndebele cultural village at the western margin of Winterveld. The present state of the environment in Winterveld clearly is not conducive to existing or future endeavours to attract more tourists.

In order to overcome the problem, some residents dig pits in their gardens to dump the waste inside. Once it has piled up high enough, they burn it and throw the ash onto the open spaces and along the roadside, if they have not already dumped the waste in these areas in the first place. When asked about these practices, the residents argued that they had sometimes seen people cleaning up the roadsides. They therefore deliberately dump their waste along the roads, hoping it will be picked up and disposed of properly by street cleaners.

Some residents also stated they deliberately dumped their waste illegally, in order to draw the authorities' attention to the lack of services in the area.

Figure 6.8 illustrates the perception of respondents regarding smell and decreased aesthetic value in their area. Respondents from the informal part of Winterveld score the highest percentage; this is attributed to the fact that they do not have waste removal services and, of course, the smell and aesthetic problems are exacerbated in their area. However, they are also the group that contributes the most to the problem by illegal dumping.

The second highest percentage of complaints comes from the formal part of Winterveld. This is interpreted as a result of the close proximity of the formal and informal parts of Winterveld, even though the formal part receives waste removal services, the rotting waste and smoke from the informal part still affects the residents in the formal part. Trash which was dumped in the informal part is picked up and redistributed by wind, waster, children, dogs, etc. to cause littering in the formal settlement.

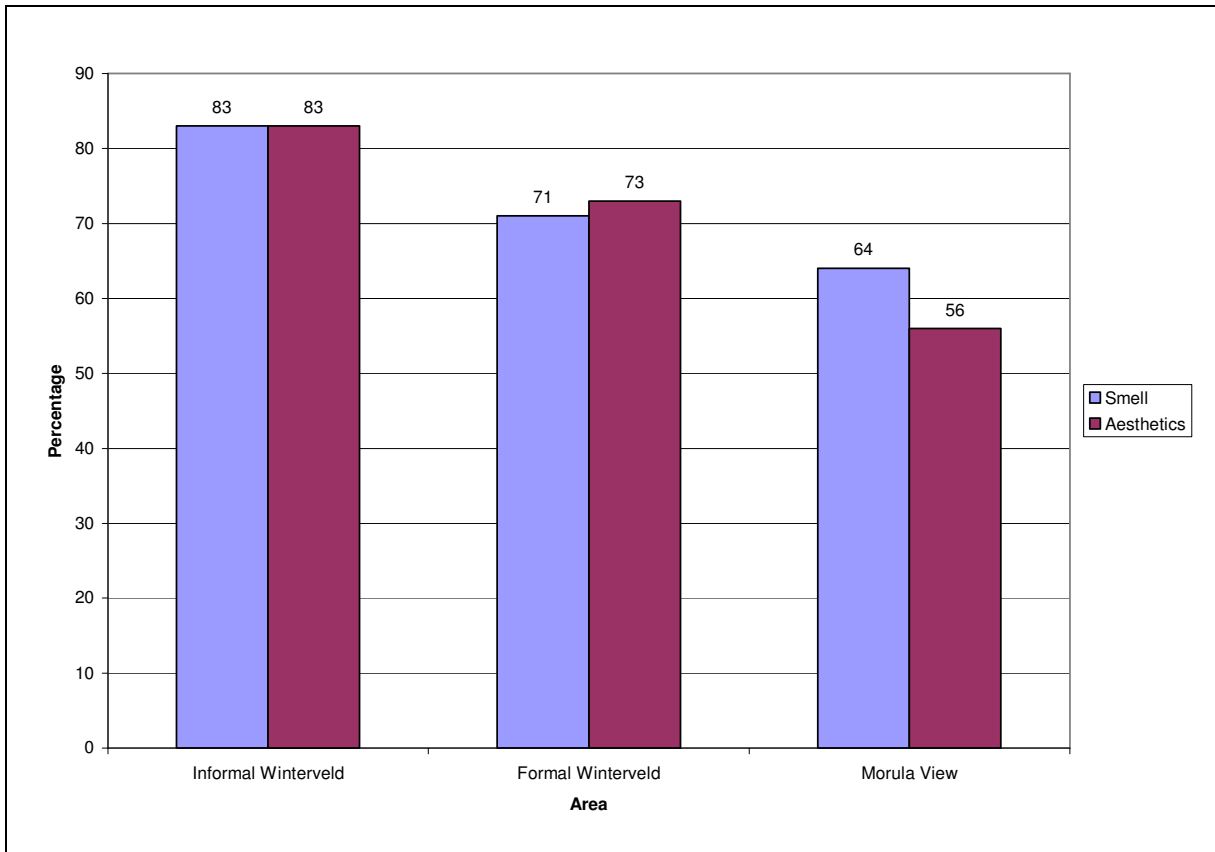


Figure 6.8: Percentage of respondents complaining about smell and poor aesthetic value induced by waste dumping and littering.

Most complaints came from the residents of informal part of Winterveld. They complain about the consequences of their own misconduct and, according to the comments, blame them on the government. The respondents from the formal settlements, in turn blame the problems on their neighbours from the informal settlement.

Data source: Questionnaire results.

6.4 Compliance of waste management practices with standards, policies and regulations

Waste management in the City of Tshwane is governed by Solid Waste By-laws which were formulated based on the relevant sections of *Municipal Systems Act* (Act No. 32 of 2000), the *Municipal Finance Management Act* (Act No. 56 of 2003) and the *White Paper on Environmental Management* (2002).

6.4.1 Waste skips as prescribed for informal areas

One of the problems that could be identified is that the *Solid Waste By-laws* do not address specific conditions in informal settlements. The *Guidelines on Waste Collection*

in High Density and Unserviced Areas (DEAT, n.d...; as discussed in Section 3.6.2) were therefore used to assess the compliance of waste management practices in informal Winterveld, to these *Guidelines*. According to the *Guidelines*, areas which do not receive household waste removal services (collection from the gate) must be supplied with skips strategically placed around the area.

During the six field work periods carried out for this study over a period of two years, however, it was found that no skips were present in Winterveld. Following this observation, the research established that attempts had indeed been made by CTMM to address the waste problem in the informal parts of Winterveld by strategically placing skips in the area in compliance with the *Guidelines* (A. Beeslaar, pers. comm., 06 April 2005). The attempt had been unsuccessful because parents sent their children to dispose of the waste inside the skip. Many children were too short to reach the top of the skips and consequently dumped the waste around them. When the Municipality realised this problem, they put old tyres around the skips so that the children could climb over them to reach the opening of the skips. Unfortunately, but not surprisingly, within a few days, the children had absconded with the tyres and used them as toys, so that the original intention had become futile again. Despite of the effort the Municipality made to instil awareness in the residents through a local radio station, the general behaviour did not change.

Eventually, the CTMM decided to remove the skips because the areas were becoming unhealthy for users, having turned into breeding sites for pests and rodents (Beeslaar, pers. comm., 06/04/2004). This unfortunate situation has not been remedied since the removal of the skips, and thus contributes to the critical waste accumulation situation in the area.

6.4.2 Community participation in service delivery

The *Guidelines on Waste Collection in High Density and Unserviced Areas* (DEAT, n.d.) also stipulate that community awareness and participation (section 4 of the *Guidelines*) are two of the most important steps to be undertaken when introducing a service to the community. According the *Guidelines*, the users of the service must be given an opportunity to understand their responsibilities through community awareness and

participation programmes; they must have a chance to suggest, to accept, or reject the service, and to voice their willingness to pay for the service.

Due to high costs of conducting a programme to raise the community's awareness, a local radio station had been used as a medium for information and raising of awareness in the case of Winterveld with regard to the placement of skips (A. Beeslaar, pers. comm., 06/04/2005). However, no information could be obtained concerning broadcasting dates and the exact information which was communicated.

The effectiveness of education and information dissemination by radio remains questionable, though, as results showed (cf. Appendix B, Question F4). An overwhelming majority of 96% of the questionnaire respondents in the informal parts of Winterveld reported that there had never been any form of community informing, training, or awareness raising regarding waste handling and disposal into the skips. Since most of these respondents have lived in the area for up to 40 years, this discrepancy between the municipality's intentions and the community's perception cannot simply be discarded as a minor error. The remaining 4% of the informal residents said they had been informed on waste-related issues at local clinics. It is thus understandable why the introduction of skips in Winterveld did not yield the anticipated result and therefore was regarded as a failure by the municipality.

The Winterveld scenario must not only be seen in a local context, but can also be compared to the situation in other developing countries. South Africa is not the only developing country that has problems regarding management of waste in informal settlements. According to Kaseva and Mbuligwe (2003), the city of Dar es Salaam, Tanzania, consists of about 70% inhabitants who live in unplanned, informal, settlements. Over the past three decades, the city has experienced major problems that were caused by poor management in informal settlements. The local authorities in the city initiated private sector involvement in waste collection and this initiative has been very successful. Three municipalities contracted two different contractors to collect waste from two different areas; one contractor collects from households and enclosures while another collects from roadsides and illegal dumps (Kaseva and Mbuligwe, 2003).

Through this initiative, Dar es Salaam has improved the amount of waste collection from 10% in 1994 to 40% in 2001 of the total waste generated daily in the city, (Kaseva and

Mbuligwe, 2003). According to CTMM, one of the main reasons why the informal settlements in South Africa do not get municipal services is that it is impossible to collect the fees for the services rendered in these areas. Even though the acts are of Winterveld residents, the results of illegal dumping and littering in these areas, affect, not only the immediate residents, but also the entire country indirectly. Unfortunately, due to the slow process of biodegrading of waste materials, the future generations are yet to suffer the consequences of the current practices.

6.4.3 Private waste management practices in informal Winterveld

Currently people in informal Winterveld, out of necessity, rather than choice, manage their own waste (cf. Appendix B). Four common practices of managing own waste are illustrated in **Figure 6.9**: Burning, burying, dumping or, least frequently, bringing it to a collection point.

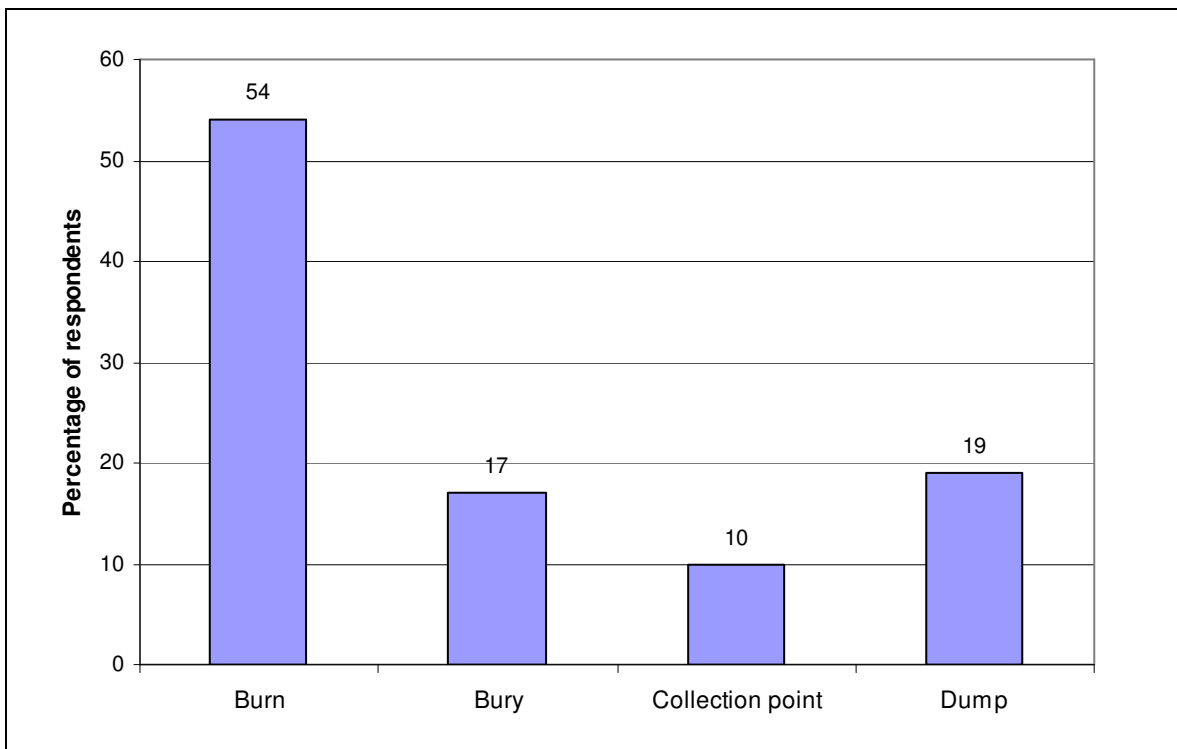


Figure 6.9: Methods used to manage waste in informal Winterveld.

More than half of all respondents burn their waste, and burning, burying or illegal dumping combined account for 90% of all answers. Only 10% of the residents use collection points.

Data source: Questionnaire results.

Each of these methods has direct (immediate) and indirect (medium- and long-term) impacts on the environment. The largest percentage (57%) of the respondents piles up waste in their own gardens and eventually burn it.

Inevitably, burning of waste is dangerous for a number of reasons which the residents either seem to be unaware of, or be unable to come up with alternatives. Firstly, fires can get out of control and destroy property and lives. Secondly, and equally importantly, ash and incompletely burned particles from burning rubbish are a nuisance; they soil property and laundry, can retard the growth of plants and reduce the palatability of grasses. When inhaled, fly ash can also affect respiratory system in people and animals. Coutsoudis *et al.* (1996) undertook a study to determine the amount and the sources of lead poisoning of children in informal settlements of Durban Metropolitan Region. The findings were that household habits associated with high lead poisoning included burning of solid waste for cooking.

Another 17% of respondents bury waste in small ditches which they dig in their gardens. These ditches serve as disposal area for all different types of waste from a household, e.g. wastewater, garden refuse, domestic waste and animal droppings. This practice induces unhealthy conditions immediately next to the living space, and the seepage from these ditches is likely to contaminate ground water – especially given the highly permeable regoliths and soils in the Winterveld area (Chapter 4.2). .

Figure 6.9 shows furthermore that 19% dump their waste; the respective interviewees indicated that they do so, hoping that the municipal workers who occasionally clean the streets will eventually collect the waste. The remaining 10% take waste to collection points, hoping that the contractors who collect waste from the serviced areas will pick it up as well; sometimes this is indeed the case, but mostly, it does not work. The waste which is not collected, but left behind, gradually is scattered all over the place, by wind, water, animals and people, and sometimes end up in the yards of people who get services.

6.4.4 Municipal waste management practices in formal Winterveld

The formal part of Winterveld and the area of Morula View receive full municipal waste removal services on weekly basis (cf. Appendix B, Section B). The households are

supplied with 85 litre steel or rubber bins, and residents are to place them at the entrance on collection days.

While this provision is made, many residents expressed their dissatisfaction about waste handling by contract workers (cf. Appendix B, Section B). In Winterveld and Morula View, 29% and 37% of the respondents respectively were not satisfied. Their main concerns and complaints are summarised in **Table 7**.

Table 7: Complaints raised by residents from formal settlements, concerning waste removal services

COMPLAINTS	CONSEQUENCES
Low collection frequency	<ul style="list-style-type: none"> • Waste rots and produces a bad smell over a week. • Residents are forced to dump some of the waste elsewhere, because the 85 litre bins are too small to hold the waste collected over a week.
Lack of punctuality	<ul style="list-style-type: none"> • Residents place waste outside the entrance in the morning, but sometimes it is only collected in the late afternoon. By then, dogs have already scattered waste over the street. • Sometimes collectors come earlier than expected, and waste which was not placed outside in time is left behind. • Residents are not informed about changes in collection days.
Bad handling	<ul style="list-style-type: none"> • Residents complain that waste collectors drop their dustbins carelessly, breaking them. • When collectors spill waste accidentally, they do not pick it up.
Inappropriate vehicles	<ul style="list-style-type: none"> • Tractors are used, which sometimes are too full and then leave trails of waste behind. • Collection tractors create a lot of noise.
Lack of information	<ul style="list-style-type: none"> • Residents do not know who is responsible for waste collection and therefore do not know where to direct their complaints. • Collectors' vehicles do not bear contract owners' information and logos, unlike vehicles used in the cities. • Residents would like to recycle some waste material, but do not have recycling facilities in their area.

Data source: Questionnaire results.

According to The Guidelines on Waste Collection in High Density and Unserviced Areas (DEAT, n.d.), waste which is transported for a distance of more than 5 km must be transported in a closed truck. All waste collected from Morula View and Winterveld is disposed of at the Soshanguve landfill site, which, however, is more than 5 km away from the serviced areas. Closed trucks should thus be the norm, not the exception.

Frequent own field observations between 2004 and 2006, however, indicate that inappropriate transportation of waste rather is the rule. In addition to the residents' reports, vehicles like the one shown in **Figure 6.9** were observed on a regular basis. The waste in the loading bay is neither adequately stacked nor sufficiently secured, which typically results in waste falling off during transportation.



Figure 6.10: Waste transport on truck with open loading bay.

The collected waste is secured by large-mesh nets. Waste bundles frequently fall off overloaded or insufficiently secured loading bays. This does not only induce untidiness, but also impose danger to other motorists and road users, not to mention the spreading of health risks from organic or other, even potentially toxic, substances.

Photo: IU Stengel, April 2004, outside of Soshanguve landfill site.

Contractors who collect waste in and around Winterveld (including Mabopane, Soshanguve and Temba) were requested to give their views on waste management practices in the area (cf. Appendix A, Sections A and B).

All six contractors who responded to the questionnaire had only started working in these areas since March 2005 (App. A, Questions A2, A3) after the previous contractor's times had elapsed; i.e. for a period of a few months only. Their own contracts will now run for five years, provided the municipality continues to be satisfied with their services for this period.

The contractor reported their general satisfaction regarding the cooperation from the residents (App. B, Questions B6 thru B9).

Collectors indicated they were using open top trucks and tractors to collect waste once in a week from house-to-house. According to them, the vehicles they use meet the requirements as set out by the municipality.

6.4.5 Environmental health and safety for waste collectors

The survey shows (cf. Appendix A, Section C) that all contractors claimed they made sure that their workers were provided with protective clothing (i.e., shoes, gloves, nose masks, etc.). However, there was no way of verifying that the workers indeed make use of their protective clothing during work. Contractors also indicated that their vehicles were in a good condition.

However, with regard to the health and environmental awareness of the workers, one contractor responded his workers had not been trained on these risk issues yet, but he was still planning to do it. All other contractors stated that their workers had been trained, but did not answer the subsequent question on who had provided this training. Obviously, these answers leave a great uncertainty as to whether the workers had indeed been trained professionally, or whether the contractors were simply issuing general warnings and safety hints themselves.

6.5 The residents' awareness and responsibility

6.5.1 Perception of health risks

To test the general knowledge of the residents regarding waste related aspects and risks, several basic questions were asked (cf. Appendix B, Section F: Awareness): mainly whether they knew, (1) the waste collector of their area; (2) the fee for waste collection services; (3) that poor waste management can cause diseases.

The first two questions are not applicable to the informal Winterveld since they do not receive municipal services. However, the awareness of the consequences of poor waste handling concerns residents from both formal and informal settlements. Their responses are illustrated in **Figure 6.11**.

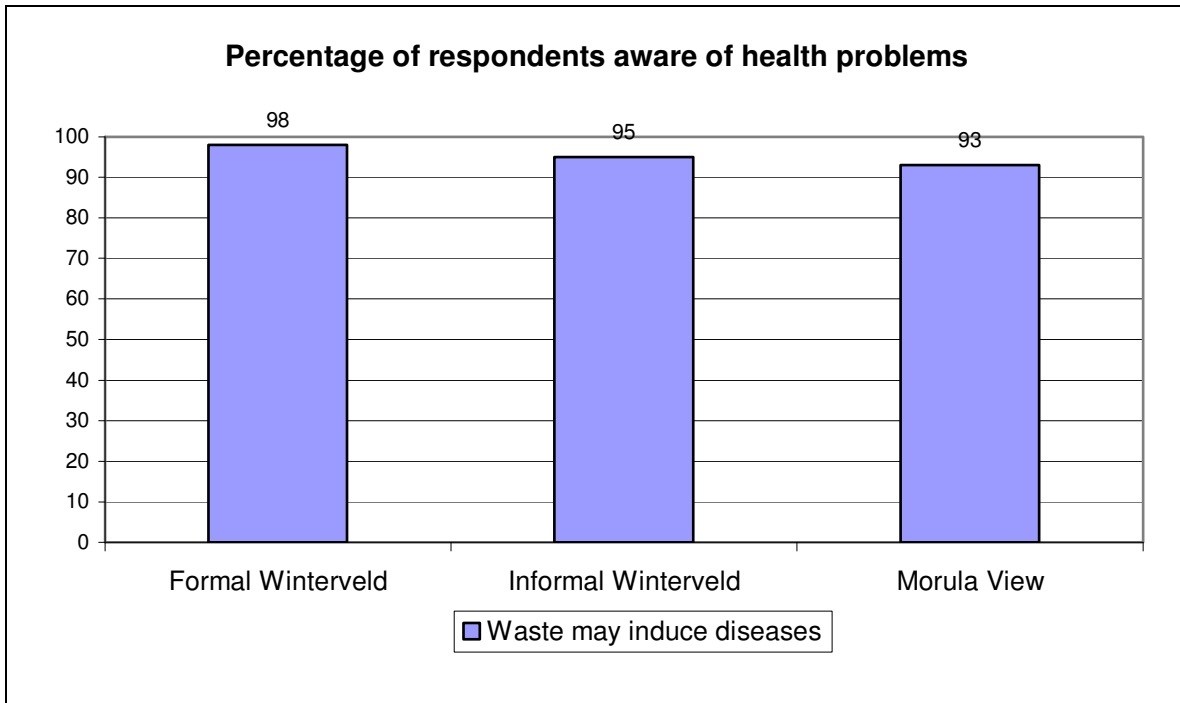


Figure 6.11: General knowledge test on health problems associated with waste.

An overwhelming percentage of all residents, from both formal and informal residents, is aware of unhealthy conditions and the risk of diseases caused by dumping waste. However, this knowledge does not seem to lead to any action or involvement in any initiatives to remedy the situation. Burning of waste is widely used (see **Figure 6.9**), but it does not solve the problem; it only shifts the pollution hazard from one form to another.

Data source: Questionnaire results.

On one hand, there is no significant difference between respondents from different areas, who do know (formal settlements) that waste can induce diseases, and those who do not know (informal settlements) (**Figure 6.11**). The Chi-square test shows there is a significant difference in knowledge level between formal and informal Winterveld. The p-value between people who know and those who do not know is 0.0016 (to indicate a significant difference, p must be >0.0001).

However, the data proves that while at least some people know about recycling initiatives, they still rather not recycle (**Figure 6.12**). Interviewees gave a number of important reasons for not recycling, which included the following:

- The companies which buy recycled waste are located too far away from the residents. This indicates both, a lack of interest on the companies' side to recruit a recycling work force in the central locations, and a lack of joint initiative in the settlements themselves, which then could probably attract a company's interest to expand their business spatially much more easily.

- The price of recycled materials is too low to make anything out of it. Again, this could be remedied by collective efforts, as larger groups of people involved in recycling could get better prices for larger quantities supplied on a regular basis, and as it in turn would stimulate recycling companies to involve the large communities with their potentially huge resources of recyclable materials.

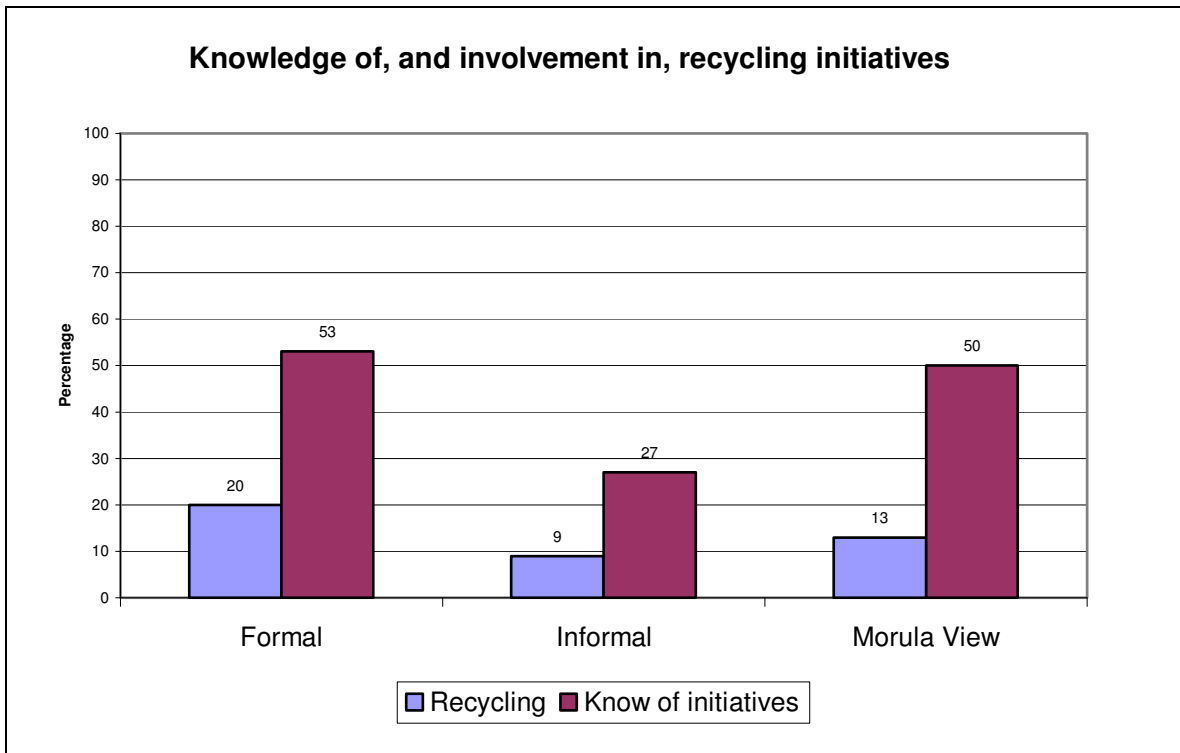


Figure 6.12: Percentage of respondents who know about recycling initiatives, versus those who actually participate in recycling.

In both formal and informal parts, there is a striking discrepancy between the relatively large percentage of people who are aware of recycling initiatives and a much smaller fraction who actually participates in them. In the formal part of Winterveld and in the control area of Morula View, as many as half of all residents indicated they knew about recycling initiatives, while still only a small portion actually does recycle some of their waste. In the informal parts, not surprisingly, both percentages are much lower, although recycling initiatives could provide valuable job opportunities, especially in the low-income areas.

Data source: Questionnaire results.

6.5.2 The residents' responsibility and willingness

Regardless of the dissatisfaction of the residents regarding the present solid waste management, a considerable percentage of respondents are still not willing to pay more money for the benefit of improving the services. When asked whether they were willing to pay higher fees to enable the municipality to improve their service, or if they rather

preferred to manage their own waste (cf. Appendix B, Section D4), responses varied, as **Figure 6.13** shows:

In formal Winterveld, a clear 75% of the respondents indicated they were willing to pay more for services, while 23% percent said they would rather manage their own waste; only 2% were not sure which option was the most suitable for them. In Morula View, only 50% are willing to pay more, while 43% would rather manage their own waste, and 7% are not sure which option they would prefer.

However, despite the surprisingly high willingness to pay more for the delivery of adequate services, the general sentiment is that the tariffs for solid waste collection are already too high. It remains to be seen, therefore, if residents would act according to their choices and really pay the required fees.



Figure 6.13: Residents' choices (*formal* settlements only) for improving waste management in their areas: pay more for services, or manage their own waste.

The data clearly indicate a high willingness to pay higher fees, rather than to take ownership and manage their own waste responsibly. However, a considerable percentage of respondents from the formal settlements are not prepared to pay more money to improve waste disposal facilities

Data source: Questionnaire results

6.6 Temporary or long-term improvement of SWM in Winterveld?

While most of the field results and questionnaire responses portray a relatively bleak scenario with severe negative environmental impacts and high levels of dissatisfaction, there were also temporary changes to the better, as observed at a number of field sites in Winterveld during the January 2005 field work. Streets were generally found to be cleaner than during the previous surveys, and the number as well as the sizes of illegal waste dumps had declined.

Figure 6.14a indicates the situation outside a primary school in Winterveld Road, in June 2004, i.e. shortly after the April 2004 National Elections. A wide zone of piled up waste marks the walkways outside the school fence. In January 2005, the litter had been cleared up completely (**Figure 6.14b**).



Figure 6.14a: Dumping outside the school yard, June 2004.

The amount of piled-up waste outside this school yard demonstrates the common misconception among residents in informal settlements that, “as long as it is not in my backyard, it is not my problem”.

Photo: LR Moilola, June 2004.



Figure 6.14b: Same school yard and pavement, October 2005.

The big illegal waste dump outside the school has totally disappeared; only scattered littering is evident. The improvement might be due to the municipality's initiative of placing waste bins along at least some streets, to encourage people to dump waste there, instead of littering indiscriminately.

Photo: LR Moilola, October 2005.

Apart from the cleaning up of littered walkways, further improvements were noted since the beginning of field work. Some of these improvements clearly indicate municipal initiatives, rather than a changed attitude of the residents towards waste-related issues. One of these municipal initiatives was the already mentioned (Chapter 6.3.) positioning of waste bins along Winterveld Road south, however, only over a distance of approx. 500m. The limited effect due to the small capacity (**Figure 6.15a**, see also **Figure 6.3**)

and too low number of the bins has already been discussed (Chapter 6.3.2). The reason for the spatial limitation of this initiative could not be determined.

Further positive changes were recorded during the last field survey in April 2006. Signs warning people not to litter had been erected, and this time indeed seemed to have made an impact, as the place looked much cleaner in general (**Figure 6.15b**).



Figure 6.15a: Placement of waste bins along the street.

Photo: LR Moiloa, April 2006.



Figure 6.15b: Recent erection of "No Dumping" signs along the streets.

Photo: LR Moiloa, April 2006.

Recent initiatives like the placing of dustbins (even though they have a limited capacity only) and the "No Dumping" signs may have contributed to the observed decline in the size and number of illegal waste dumps in Winterveld since the beginning of the study.

It remains to be seen, however, if this obvious improvement represents a long-term change for the better, including an increased responsibility of the respective residents, or if it is merely an effect of the clearing campaigns just before the 2006 Local Elections (01 March 2006), with their very strong emphasis on service delivery and performance.

7. CONCLUSIONS

7.1 Conclusions

Waste management is increasingly becoming a problem, especially in densely populated informal settlements along urban fringes. In South Africa, there are numerous national and municipal legislative acts, regulations and by-laws, which are supposed to control pollution, littering in general, and illegal dumping of waste in particular. Yet, all these prohibited actions are evident all over the country, and, as was presented in the study, in an exacerbated way in informal settlements like the investigated parts of Winterveld. There is an urgent need to identify, understand, and address the difficulties experienced in managing solid waste in informal settlement.

The results, based on multiple field work and detailed surveys, clearly show that there is an obvious lack in the enforcement part of legislation, on the side of the government and/or municipality.

Even though some changes for the better were observed locally and temporarily, the state of the environment in Winterveld due to non-existent or insufficient waste management is still deteriorating. The role of both waste management services and the residents is crucial. The main parameters are economic, such as lack of affordable alternatives, but also, and probably mainly, social/ educational factors, lack of awareness, lack of responsibility, and lack of participation. One of the important results is that not only the informal parts of Winterveld themselves are affected by the lack of waste removal, but that this even has implications on some of the formal parts of Winterveld, both environmentally and aesthetically, due to the close proximity and interspacing of the formal and informal parts (**Figure 4.1**).

7.2 Recommendations

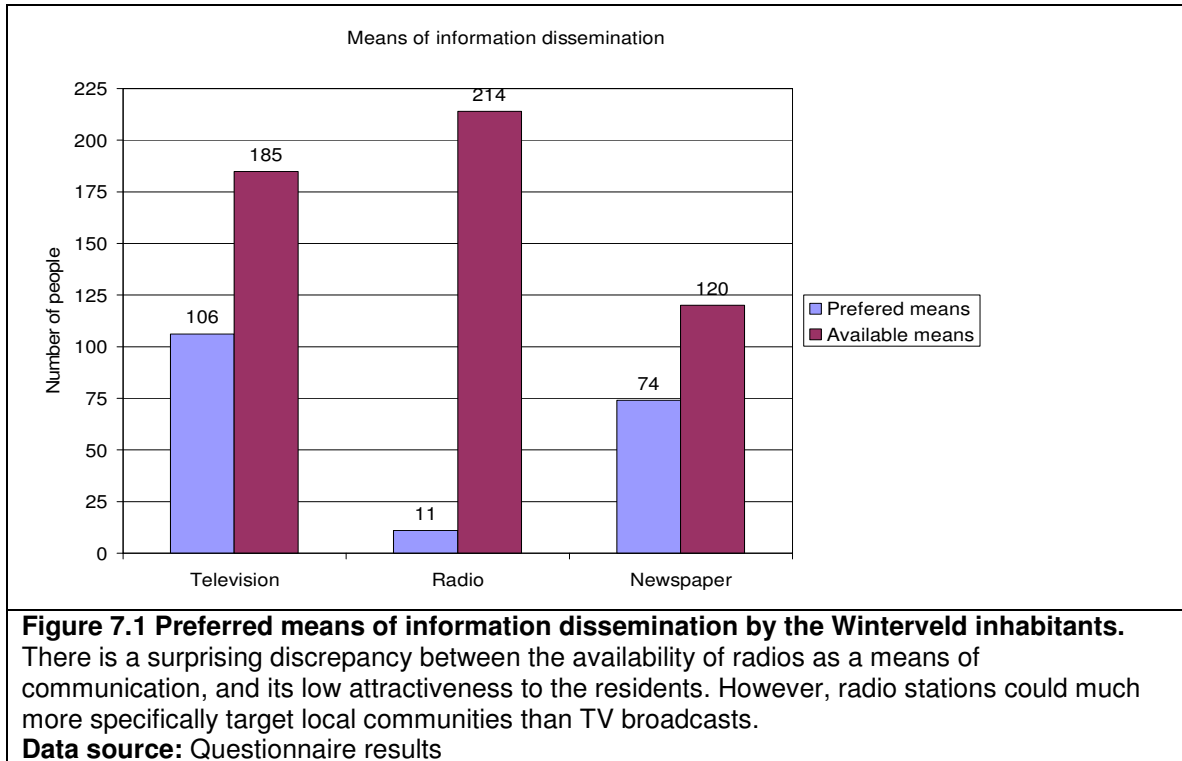
The results of this study can serve as a basis for future improvements of the current situation, both in Winterveld specifically, and even in other urban fringe settlements in general.

- There is an urgent need to research further directions of action regarding waste management in informal settlements of South Africa. Of all the problems and

concerns established in this study, especially the affordability of municipality services is a major issue for in the future success of solid waste management in Winterveld.

- Public Participation Process (PPP) could play an effective role in establishing the needs of the community, their willingness to pay, and then incorporate different suggestions they might come up with. As only a certain percentage of the total inhabitants could be covered in this study, it is therefore recommended that the whole community be involved in a future participatory approach by the authorities themselves, in order to solve the state of waste management in Winterveld in the long run.
- Although the majority of people indicated that they have access to a radio, this is clearly the least preferred method of information dissemination. The second-most widespread communication media is television, and it is also the most preferred means of information (**Figure 7.1**). Due to the high attraction of television in general, it can be assumed that this ranking of the communication media might be similar in other urban-fringe settlements as well. The radio is certainly not used to its capacity as a mass medium for environmental education yet.

As television would not be able to address local communities and specific settlements, there is a distinctive need for making the almost ubiquitous radio more attractive as a means to distribute information which is both relevant and attractive community. It is therefore recommended that the municipality closely cooperate with local and national radio stations and news bulletin editors, as well as further encourage the community to use radios and other sources of information, on a regular basis.



- Through this research, it could also be established that some residents who do get waste removal services are neither paying for the service, nor are they willing to pay. This obviously constitutes an increasing problem for the municipality because the contractors still need to be paid. At the same time, it was expressed as a common sentiment among all respondents that the fees for waste removal services are already too high. In this regard, the municipality should consider a meeting with the residents where they will present financial implications involved in waste management.
- The municipality should also ensure that the contractors use roadworthy vehicles which securely stow the waste onto truck, in order to avoid the typical scenes as those presented in **Figure 6.10**. Possibly a sort of monitoring system could be established by the municipality, which then must be signed by the service provider upon agreement of the contract. Maybe voluntary quality and monitoring agreements among the contractors could also help to ensure that waste services are being undertaken under best safety practices.

- The composting of organic waste is recommended at household level where the compost waste can be used as natural fertilisers for vegetable production. This exercise has been very successful in reducing illegal dumping in both developed (Norway among many others) and developing countries (e.g. Tanzania). However, the same level of success might not be achieved in Winterveld because the area is densely populated, with not enough space to conduct vegetable gardening. This recommendation would have to work hand-in-hand with encouraging horticulture in the less densely built-up areas of the settlement.
- The municipality is encouraged to place more and maybe larger, easily accessible kerbside waste bins and at more even spacing, as well as reconsider the option of placing skips, as required by the *Guidelines*. This must be complemented by information and education campaigns for the residents of Winterveld, how to best utilise the facilities. Although this initiative had failed earlier on because parents sent children to dispose of waste in the kerbside bins, most children could not reach the opening of the bins, and large amounts of waste were simply dumped around the bins.
- The type of waste bin (stable, not too permeable instead of meshed wire, easily to be emptied, size) must also be reconsidered, to avoid the present messy situation around waste bins in future.
- Acceptance and participation of the residents could be improved if the members of the community who would normally recycle at the landfill sites could be encouraged to work at the waste bins and skips. These workers would ensure that the residents do not abuse the facility, and it would be easier for them to work closer to home.
- On a larger scale, producers should be encouraged to buy back from the consumers, some of their products which are recyclable. Successful examples are South African Breweries who successfully recover bottles from consumers, and Mondi Business Paper who buy back waste paper. Non-breakable materials such as plastic bottles, cans, tins, lend themselves to similar initiatives. It is therefore recommended that other companies initiate or encourage buying back, recovery, bottle levies, - which also should be encouraged, and, possibly, encoded, by respective by-laws and policies.

- Communities should be informed regularly, as well as educated at all age levels, about companies involved in recycling, as well as job opportunities available in recycling, at both formal and informal level. The design, location, and management of waste collection facilities must be done in full participation of the affected community. This could prove to be invaluable, especially for the illiterate part of community without any formal training or qualification for specialised jobs.

The research has revealed sub-facial problems in waste management in informal settlements along urban fringes. There is no planned structure in these settlements and thus it is difficult for municipality and government to provide adequate waste removal services since the clustered houses do not have access roads. It would even be more difficult for the CTMM to collect fees for waste removal services from these clustered and densely populated stands, because owners are not registered and do not have title deeds and, for the most part, addresses to which bills could be delivered. Many times, government efforts are also strongly opposed by the actions of the residents themselves. Further research needs to be conducted to establish the source of negative attitudes and to then come up with solutions. An extensive and continuous Public Participation and Awareness campaign is highly recommended in this regard.

Even though there has been a decline in the overall number of dumpsites since the placements of dustbins, this is not a long-term solution, especially since the dustbins have only been placed along certain main roads only. It is at least a positive indication from the residents' side that some of them are willing to cooperate for the benefit of their immediate environment. However, the community as a whole needs to be informed and educated about the hazards they are exposing themselves to by mishandling waste.

There is a need to further investigate suitable facilities and strategies to manage waste in informal settlements. Even though the most negative impacts induced by mishandling of waste are spatially localised, this problem should urgently be tackled at a national level, and it is our call as scientist and researchers to provide the necessary information base for intervention.

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Appendix A: Questionnaire for Contractors

Questionnaire for Waste Collectors in the Tshwane Municipality Area

This survey is conducted to better understand Solid Waste Management practices in the Tshwane Municipality area.

Since waste collectors play an important role in the management of waste, both in urban and urban-fringe areas, this questionnaire was compiled to gain information on the efficiency and possible problems of domestic waste collection.

- **All questionnaires will be treated and evaluated ANONYMOUSLY.**

Please help me to conduct this survey by answering the questions contained in the questionnaire.

There are no 'right' or 'wrong' answers. Please answer sincerely and to the best of your knowledge, as the outcome of the study might be very helpful for you, too.

-
- ***Please keep this cover sheet.***
 - ***Please send the completed questionnaire back to:***

Ms Lebohang Moiloa (BSc), (BSc Hons) Geography
Dept of Geography, Geoinformatics & Meteorology
University of Pretoria
Lynnwood Road
Pretoria 0002

- **The questionnaire is anonymous. The answers cannot be linked to any contractor.**

THANK YOU VERY MUCH for your co-operation!

Date:

QUESTIONNAIRE

Waste and Waste Removal in the Tshwane Metropolitan Municipality

A Areas and Services

Please fill in the table below, to answer the following questions:

A1 In which areas do you operate? *Areas, suburbs, blocks, etc.*

A2 Which services do you provide for those areas?

A3 For how long have you been operating in each area?

(A1) Areas / suburbs / zone...	(A2) Type of service					(A3) Since when have you been providing these services?
	Waste collection	Waste re-use	Waste recycling	Land filling	Other (please name)	
Area...						
Area...						
Area...						
Area...						

B Collection Methods

Please complete the following tables for each area in which you operate.

AREA

B1 Which collection method(s) do you use? *E.g. door-to-door, from the kerbside (a point where individual households dump their waste for further collection), from a central collection point...*

B2 Have you always applied the same methods all the time? If no, how have the methods changed?

(B1) Collection method	(B2) From when to when		
	From when to when (years)	From when to when (years)	From when to when (years)
Door-to-door			
Kerbside			
Central collection point			
Other			
Other			

B3 Collection method: *door-to-door, kerbside, central collection point, other*

B4 Frequency: *Daily / Once a week / 2x per week / 3x per week / Every second week / Monthly / other*

B5 Quantity: *Number of bags, containers... please specify.*

B6 How well do the residents cooperate with your waste collection:

- *Excellent: Bags are not torn; bags are tied close, stacked together, always on time for collection.*
- *Good: Some bags are torn; some of the waste has spilled out, littering the place.*
- *Fair: Most of the waste is not properly packed into bags, the collection point is messy.*
- *Poor: It is impossible to collect the waste properly, because it is spread all over the place.*

(B3) Collection method	(B4) Frequency	(B5) Quantity	(B6) Cooperation from people
Door to door			
Kerbside			
Central collection point			
Other			
Other			

B7 What are the most frequently/persistently occurring problems if any?

B8 What do you think could be done to solve the problems?

B9 Do the residents do any sorting or separation of different types of waste?

Point of waste separation	(B9) Waste separation, yes or no?	
	NO	YES. Please explain how they separate it
In the household		
On the kerbside		
At the central collection point		
Other place		

B10 Have you noticed any differences in the quantity and composition of waste, with time of the week or month or season?

NO		
YES		How do they differ?
		Why do you think they differ?

C Workers and Equipment

C1 What type of trucks do you use?

Open top		Closed top		Other (please specify)	
----------	--	------------	--	------------------------	--

C2 Do they comply with national standards?

YES		How do they deviate?
NO		
		Why do they deviate?

C3 Did your drivers and collectors receive any basic training on safety, health and environment of their working environment?

YES		Where did they receive the training?
NO		Why not?

C4 Are the workers provided with protective clothing when on duty?

YES		
NO		Why not?

D Standards, Legislation and Laws

D1 How do you rate the standards that the Municipality sets for waste collection; can you meet them?

Adequate (standards can easily be met)		Too high (standards are unrealistic, can never be met)		Too low (standards should be higher)	
--	--	--	--	--------------------------------------	--

D2 Any comments you wish to make?

D3 How do you rate the SA legislation (environmental laws, environmental evaluations....) related to Waste Management?

Excellent:	Comprehensive and sufficient	
Good:	Minor gaps and inadequacies	
Satisfactory:	Some gaps and inadequacies	
Poor:	Significant gaps and inadequacies	
Very poor:	Fundamental flaws and weaknesses	
No opinion:	Insufficient basis and experience from which to judge	

Please tick the appropriate box

D4 How does the SA legislation affect your service?

D5 Are there any other factors that affect your operations?

D6 Are you involved in any of the following? Please tick the appropriate box.

	YES	NO
Train managers/ administrators, collectors, recyclers, and re-users		
Design and/or implement new strategies for Waste Management, collection, separation, recycling...		
Conduct research that provides a basis for improved Waste Management		
Conduct research on management processes and/or policies		
Establish policies or procedures for Waste Management		
Design or conduct monitoring programmes		
Any other role		

E Environmental Considerations

E1 Are you aware of any environmental impacts of your operations?

NO		
YES		What kind of problem(s)?
		How could the problem(s) be solved?

E2 Any suggestions on how to improve your services (e.g. alternative waste collection systems, transportation, etc.).

Appendix B: Questionnaire for Residents

Lebohang Moiloa (BSc Hons) Geography

MSc Study: **Solid Waste Management in Urban Fringe Settlements: The Case of Winterveld, Pretoria.**

Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Lynnwood Road, Pretoria 0002.
(Cell) 073-2324312; (tel) 012-343 9538, (fax) 012 - 420 3284; (e-mail) s23060256@tuks.co.za OR moiloalr@ananzi.co.za.
Supervisor: Dr I U Stengel, (tel) 012 - 420 3710, (fax) 012 - 420 3284

Questionnaire for Waste Collectors in the Tshwane Municipality Area

This survey is conducted to better understand Solid Waste Management practices in the Tshwane Municipality area.

Since residents play an important role in the management of waste, both in urban and urban-fringe areas, this questionnaire was compiled to gain information on the efficiency and possible problems of domestic waste collection services and the role played by the community.

- **All questionnaires will be treated and evaluated ANONYMOUSLY.**

Please help me to conduct this survey by answering the questions contained in the questionnaire.

There are no 'right' or 'wrong' answers. Please answer sincerely and to the best of your knowledge, as the outcome of the study might be very helpful for you, too.

Mrs Lebohang Moiloa (BSc), (BSc Hons) Geography
Dept of Geography, Geoinformatics & Meteorology
University of Pretoria
Lynnwood Road
Pretoria 0002

- **The questionnaire is anonymous. The answers cannot be linked to anyone.**

THANK YOU VERY MUCH for your co-operation!

DATE:

Respondent number

V1 1-3

A. Household information

A1. Gender
Male/ Female

V2 4

A2. For how many years have you stayed here?

V3 5-6

A3. How many people live in your yard?

V4 7-8

A4. Do you have a job?

No		Yes	Formal job (permanent or contract)		Pensioner
			Informal		
			Occasional		

V5 9

A5. What is the total income of your family per month?

R 0 - R 750	R 751 - R 1500	R 1501 - R 3000	>R 3000
-------------	----------------	-----------------	---------

V6 10

A6. What is your educational level?

Primary		Secondary		Job training		Tertiary		None
---------	--	-----------	--	--------------	--	----------	--	------

V7 11

A7. Which source of energy do you use for cooking?

Electricity	
Paraffin	
Firewood	
Coal	
Other	
Other	
Other	

V8 12
 V9 13
 V10 14
 V11 15
 V12 16
 V13 17
 V14 18

A8. Which source of energy do you use for heating?

Electricity	
Paraffin	
Firewood	
Coal	
Other	
Other	

V15 19
 V16 20
 V17 21
 V18 22
 V19 23
 V20 24

A9. Do you have access to the following?	
Television	
Radio	
Daily newspaper	
Weekly newspaper	

V21	<input type="checkbox"/>	25
V22	<input type="checkbox"/>	26
V23	<input type="checkbox"/>	27
V24	<input type="checkbox"/>	28

A10. Do you have a vehicle that you could use transport your own waste			
Yes	<input type="checkbox"/>	No	<input type="checkbox"/>

V25	<input type="checkbox"/>	29
-----	--------------------------	----

A11. Give the order of importance to the following	
Water supply	
Electricity supply	
Sewage removal	
Waste removal	

V26	<input type="checkbox"/>	30
V27	<input type="checkbox"/>	31
V28	<input type="checkbox"/>	32
V29	<input type="checkbox"/>	33

B. Waste collection and reliability

B1. Where do you get refuse bags?			
Provided	<input type="checkbox"/>	Buy	<input type="checkbox"/>
		None used	<input type="checkbox"/>

V30	<input type="checkbox"/>	34
-----	--------------------------	----

B2. How many refuse bags do you fill in a week?

V31	<input type="checkbox"/>	35
-----	--------------------------	----

B3. Is waste collected from your area?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
Where?	Gate	<input type="checkbox"/>	Central collection point
			<input type="checkbox"/>
	What do you do with it?		<input type="checkbox"/>

V32	<input type="checkbox"/>	36
V33	<input type="checkbox"/>	37
V34	<input type="checkbox"/>	38

B4. How many times a week is the waste collected?

V35	<input type="checkbox"/>	39
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B5. When is the waste collected?

Same day same time	<input type="checkbox"/>	Same day different times	<input type="checkbox"/>	Different days different times	<input type="checkbox"/>
--------------------	--------------------------	--------------------------	--------------------------	--------------------------------	--------------------------

V36	<input type="checkbox"/>	40
-----	--------------------------	----

B6. Is all waste removed?

Yes	<input type="checkbox"/>	No	<input type="checkbox"/>
-----	--------------------------	----	--------------------------

V37	<input type="checkbox"/>	41
-----	--------------------------	----

C. Your views on waste collection

C1. Has waste collection changed since you moved here?

Yes	<input type="text"/>	No	<input type="text"/>		V38	<input type="text"/>	42
How has it changed?					V39	<input type="text"/>	43

C2. Do you know the waste collector of your area?

Yes	<input type="text"/>	No	<input type="text"/>		V40	<input type="text"/>	44
Who is/ do you think it is?					V41	<input type="text"/>	45

C3. Do you think waste collection in your area is of the same standard as else where in South Africa?

Yes	<input type="text"/>	No	<input type="text"/>		V42	<input type="text"/>	46
How do you think it differs?					V43	<input type="text"/>	47
Why do you think it differs?					V44	<input type="text"/>	48

D. Satisfaction

D1. How many times per week would you like waste to be removed? V45 49

D2. Are you satisfied with service of waste collectors?

Yes	<input type="text"/>	No	<input type="text"/>		V46	<input type="text"/>	50
Do you inform the authorities?					V47	<input type="text"/>	51
Yes	<input type="text"/>	No	<input type="text"/>		V48	<input type="text"/>	52
What do you do?							

D3. How much do you pay for waste collection services per month? V49 53-55 |

D4. What would you rather do:

Pay more to improve the services?	<input type="text"/>	Remove it yourself?	<input type="text"/>		V50	<input type="text"/>	56
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E. Waste separation and recycling

E1. Do you separate different waste components before disposal?

Yes		No					
				V51	[]		57
If yes, which ones?							
Ash				V52	[]		58
Animal droppings				V53	[]		59
Waste food				V54	[]		60
Plastic				V55	[]		61
Glass				V56	[]		62
Cans				V57	[]		63

E2. Do you do any recycling?

Yes		No					
				V58	[]		64
Where?							
My yard				V59	[]		65
Central collection point				V60	[]		66
At the landfill				V61	[]		67
Other (specify)				V62	[]		68

E3. What materials do you specifically recycle?

Plastic							
				V63	[]		69
Glass				V64	[]		70
Paper				V65	[]		71
Other (please specify)				V66	[]		72
Other (please specify)				V67	[]		73
Other (please specify)				V68	[]		74

E4. Are you aware of any waste recycling initiatives?

Yes		No					
				V69	[]		75
Which ones?				V70	[]		76-77

E5. Do you sell any recycled products?

No		Yes					
				V71	[]		78
Who is your customer?				V72	[]		79-80
How much income do you get?				V73	[]		81-84

E6. What do you consider the most important reason for your recycling?

Additional income		Environmental benefits		Health benefits			
				V74	[]		85

E7. What do you think should be done to make recycling attractive for you?

				V75	[]		86-87

F. Awareness

F1. Have you heard of people being injured by waste objects lying in the streets?

Yes		No			V76		88
How many cases in a month?					V77		89-90

F2. Have you heard of any cases of animals dying from eating plastics?

Yes		No			V78		91
How many cases in a month?					V79		92-93

F3. Are you aware that improper handling and removal of waste might cause diseases?

Yes		No			V80		94
-----	--	----	--	--	-----	--	----

F4. Has there been any training and/ or information dissemination in your community on health and environmental issues, with regard to waste?

Yes		No			V81		95
Who provided the information					V82		96-97

F5. In the future, how would you like to be informed about waste related matters?

Television				V83		98
Radio				V84		99
Newspaper				V85		100
Meetings				V86		101
Other (please specify)				V87		102
Other (please specify)				V88		103

F6. What do you think could be done to stop people from littering?

				V89		104
--	--	--	--	-----	--	-----

F7. What other problems do you notice in your areas that are related to waste and waste removal?

Smell				V90		105
Water Pollution				V91		106
Aesthetics (Looks)				V92		107
Other (please specify)				V93		108
Other (please specify)				V94		109
Other (please specify)				V95		110

Appendix C: Examples of Returned Questionnaires

C1: Contractors' Questionnaire

Lebohlag Moiloa (BSc Hons) Geography
MSc Study: Solid Waste Management in Urban Fringe Settlements: The Case of Winterveld, Pretoria.
 Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Lynnwood Road, Pretoria 0002.
 (Cell) 073-2324312; (tel) 012-343 9538, (fax) 012 - 420 3284; (e-mail) s23060256@tuks.co.za OR thamaelr@ananzi.co.za.
 Supervisor: Dr I U Stengel, (tel) 012 - 420 3710, (fax) 012 - 420 3284

Date: 10/05/2005

QUESTIONNAIRE
Waste and Waste Removal in the Tshwane Metropolitan Municipality

A Areas and Services

Please fill in the table below, to answer the following questions:

- A1 In which areas do you operate? *Areas, suburbs, blocks, etc.*
- A2 Which services do you provide for those areas?
- A3 For how long have you been operating in each area?

(A1) Areas / suburbs / zone...	(A2) Type of service					(A3) Since when have you been providing these services?
	Waste collection	Waste re-use	Waste recycling	Land filling	Other (please name)	
<i>SOUTH SOUTH AREAS</i>	<i>WASTE COLLECTION</i>					
Area...	<input checked="" type="checkbox"/>					<i>01 MARCH 2005</i>
Area...						
Area...						
Area...						

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B Collection Methods

Please complete the following tables for each area in which you operate.

AREA B3 DUMARQUE SOUTH

B1 Which collection method(s) do you use? E.g. door-to-door, from the kerbside (a point where individual households dump their waste for further collection), from a central collection point....

B2 Have you always applied the same methods all the time? If no, how have the methods changed?

(B1) Collection method	(B2) From when to when		
	From when to when (years)	From when to when (years)	From when to when (years)
Door-to-door <u>X</u>	<u>2005 - 2008</u>		
Kerbside			
Central collection point			
Other			
Other			

B3 Collection method: door-to-door, kerbside, central collection point, other

B4 Frequency: Daily / Once a week / 2x per week / 3x per week / Every second week / Monthly / other

B5 Quantity: Number of bags, containers... please specify.

B6 How well do the residents cooperate with your waste collection:

- Excellent: Bags are not torn; bags are tied close, stacked together, always on time for collection.
- Good: Some bags are torn; some of the waste has spilled out, littering the place.
- Fair: Most of the waste is not properly packed into bags, the collection point is messy.
- Poor: It is impossible to collect the waste properly, because it is spread all over the place.

(B3) Collection method	(B4) Frequency	(B5) Quantity	(B6) Cooperation from people
Door to door <u>X</u>	<u>EVERY DAY PER AREA</u>	<u>18 TONS</u>	<u>GOOD</u>
Kerbside			
Central collection point			
Other			
Other			

B7 What are the most frequently/persistently occurring problems if any?

ILLEGAL DUMPINGS

B8 What do you think could be done to solve the problems?

TO involve the Community leaders in discussions

B9 Do the residents do any sorting or separation of different types of waste?

Point of waste separation	(B9) Waste separation, yes or no?	
	NO	YES. Please explain how they separate it
In the household	<u>X</u>	
On the kerbside		
At the central collection point		
Other place		

B10 Have you noticed any differences in the quantity and composition of waste, with time of the week or month or season?

NO	
YES	<u>X</u>
How do they differ? <u>Few days after Month more waste is collected</u>	
Why do you think they differ? <u>More tons of waste are collected on these days</u>	

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C Workers and Equipment

C1 What type of trucks do you use?

Open top	<input checked="" type="checkbox"/>	Closed top	Other (please specify)
----------	-------------------------------------	------------	------------------------

C2 Do they comply with national standards?

YES	<input checked="" type="checkbox"/>	
NO		How do they deviate?
Why do they deviate?		

3 Did your drivers and collectors receive any basic training on safety, health and environment of their working environment?

YES	<input checked="" type="checkbox"/>	Where did they receive the training?
NO	<input checked="" type="checkbox"/>	Why not? <i>still on planning</i>

C4 Are the workers provided with protective clothing when on duty?

YES	<input checked="" type="checkbox"/>	<i>Safety shoes - gloves, nose masks</i>
NO		Why not?

D Standards, Legislation and Laws

D1 How do you rate the standards that the Municipality sets for waste collection; can you meet them?

Adequate (standards can easily be met)	Too high (standards are unrealistic, can never be met)	Too low (standards should be higher)
		<input checked="" type="checkbox"/>

D2 Any comments you wish to make?

payments are not met on time. Resulting in causing problems to contractors to run their daily activities

D3 How do you rate the SA legislation (environmental laws, environmental evaluations....) related to Waste Management?

Excellent: Comprehensive and sufficient	
Good: Minor gaps and inadequacies	
Satisfactory: Some gaps and inadequacies	<input checked="" type="checkbox"/>
Poor: Significant gaps and inadequacies	
Very poor: Fundamental flaws and weaknesses	
No opinion: Insufficient basis and experience from which to judge	

Please tick the appropriate box

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 Supervisor: Dr I U Stengel, (tel) 012 - 420 3710, (fax) 012 - 420 3284

D4 How does the SA legislation affect your service?

NONE

D5 Are there any other factors that affect your operations?

Rain: poor of internal roads

D6 Are you involved in any of the following? Please tick the appropriate box.

	YES	NO
Train managers/ administrators, collectors, recyclers, and re-users		<input checked="" type="checkbox"/>
Design and/or implement new strategies for Waste Management, collection, separation, recycling...	<input checked="" type="checkbox"/>	
Conduct research that provides a basis for improved Waste Management		<input checked="" type="checkbox"/>
Conduct research on management processes and/or policies	<input checked="" type="checkbox"/>	
Establish policies or procedures for Waste Management	<input checked="" type="checkbox"/>	
Design or conduct monitoring programmes		<input checked="" type="checkbox"/>
Any other role		<input checked="" type="checkbox"/>

E Environmental Considerations

E1 Are you aware of any environmental impacts of your operations?

NO	<input checked="" type="checkbox"/>	
YES		What kind of problem(s)?
		How could the problem(s) be solved?

E2 Any suggestions on how to improve your services (e.g. alternative waste collection systems, transportation, etc.).

N/A

Appendix C: Examples of Returned Questionnaires

C2: Residents' Questionnaire

17/09/05

DATE:

245

Respondent number

V1 1-3

A. HOUSEHOLD INFORMATION

A1. Gender
Male/ Female

V2 1 4

A2. For how many years have you stayed here? 15

V3 15 5-6

A3. How many people live in your yard? 6

V4 6 7-8

A4. Do you have a job?
No Yes Formal job (permanent or contract) Pensioner
Informal
Occasional

V5 2 9

A5. What is the total income of your family per month?
R 0 - R 750 R 751 - R 1500 R 1501 - R 3000 >R 3000

V6 4 10

A6. What is your educational level?
Primary Secondary Job training Tertiary None

V7 4 11

A7. Which source of energy do you use for cooking?
Electricity
Paraffin
Firewood
Coal
Other
Other
Other

V8 1 12
V9 0 13
V10 0 14
V11 0 15
V12 0 16
V13 0 17
V14 0 18

A8. Which source of energy do you use for heating?
Electricity
Paraffin
Firewood
Coal
Other
Other

V15 1 19
V16 0 20
V17 0 21
V18 0 22
V19 0 23
V20 0 24

A9. Do you have access to the following?	
Television	<input checked="" type="checkbox"/>
Radio	<input checked="" type="checkbox"/>
Daily newspaper	<input checked="" type="checkbox"/>
Weekly newspaper	<input checked="" type="checkbox"/>

V21	1	25
V22	1	26
V23	1	27
V24	1	28

A10. Do you have a vehicle that you could use transport your own waste			
Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>

V25	1	29
-----	---	----

A11. Give the order of importance to the following	
Water supply	1
Electricity supply	2
Sewage removal	3
Waste removal	4

V26	1	30
V27	2	31
V28	3	32
V29	4	33

B. Waste collection and reliability

B1. Where do you get refuse bags?			
Provided	<input type="checkbox"/>	Buy	<input checked="" type="checkbox"/>
		None used	<input type="checkbox"/>

V30	2	34
-----	---	----

B2. How many refuse bags do you fill in a week?
1

V31	1	35
-----	---	----

B3. Is waste collected from your area?			
Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Where?	Gate	<input checked="" type="checkbox"/>	Central collection point
What do you do with it?			

V32	1	36
V33	1	37
V34	1	38

B4. How many times a week is the waste collected?
1

V35	1	39
-----	---	----

B5. When is the waste collected?		
Same day same time	<input checked="" type="checkbox"/>	Same day different times
		Different days different times

V36	1	40
-----	---	----

B6. Is all waste removed?	
Yes	<input type="checkbox"/>
No	<input checked="" type="checkbox"/>

V37	2	41
-----	---	----

C. Your views on waste collection

C1. Has waste collection changed since you moved here?

Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	V38	<input type="checkbox" value="2"/>	42
How has it changed?				V39	<input type="checkbox"/>	43

C2. Do you know the waste collector of your area?

Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	V40	<input type="checkbox" value="2"/>	44
Who is/ do you think it is?				V41	<input type="checkbox"/>	45

C3. Do you think waste collection in your area is of the same standard as else where in South Africa?

Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>	V42	<input type="checkbox" value="1"/>	46
How do you think it differs?				V43	<input type="checkbox"/>	47
Why do you think it differs?				V44	<input type="checkbox"/>	48

D. Satisfaction

D1. How many times per week would you like waste to be removed? V45 49

D2. Are you satisfied with service of waste collectors?

Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>	V46	<input type="checkbox" value="1"/>	50
Do you inform the authorities?				V47	<input type="checkbox"/>	51
Yes	<input type="checkbox"/>	No	<input type="checkbox"/>	V48	<input type="checkbox"/>	52
What do you do?						

D3. How much do you pay for waste collection services per month? ^{R50} V49 53-55

D4. What would you rather do:

Pay more to improve the services?	<input type="checkbox"/>	Remove it yourself?	<input type="checkbox"/>	V50	<input type="checkbox"/>	56
-----------------------------------	--------------------------	---------------------	--------------------------	-----	--------------------------	----

E. Waste separation and recycling

E1. Do you separate different waste components before disposal?

Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	V51	<input type="checkbox" value="2"/>	57
If yes, which ones?						
Ash	<input type="checkbox"/>			V52	<input type="checkbox"/>	58
Animal droppings	<input type="checkbox"/>			V53	<input type="checkbox"/>	59
Waste food	<input type="checkbox"/>			V54	<input type="checkbox"/>	60
Plastic	<input type="checkbox"/>			V55	<input type="checkbox"/>	61
Glass	<input type="checkbox"/>			V56	<input type="checkbox"/>	62
Cans	<input type="checkbox"/>			V57	<input type="checkbox"/>	63

F3. Are you aware that improper handling and removal of waste might cause diseases?					
Yes	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>	V80	1

94

F4. Has there been any training and/ or information dissemination in your community on health and environmental issues, with regard to waste?					
Yes	<input type="checkbox"/>	No	<input checked="" type="checkbox"/>	V81	2
Who provided the information				V82	

95

96-

97

F5. In the future, how would you like to be informed about waste related matters?					
Television	<input checked="" type="checkbox"/>			V83	1
Radio	<input checked="" type="checkbox"/>			V84	1
Newspaper	<input checked="" type="checkbox"/>			V85	1
Meetings	<input type="checkbox"/>			V86	1
Other (please specify)	<input type="checkbox"/>			V87	
Other (please specify)	<input type="checkbox"/>			V88	

98

99

100

101

102

103

F6. What do you think could be done to stop people from littering?					
<i>Put dustbins on the streets</i>				V89	1

104

F7. What other problems do you notice in your areas that are related to waste and waste removal?					
Smell	<input checked="" type="checkbox"/>			V90	1
Water Pollution	<input type="checkbox"/>			V91	0
Aesthetics (Looks)	<input checked="" type="checkbox"/>			V92	1
Other (please specify)	<input type="checkbox"/>			V93	
Other (please specify)	<input type="checkbox"/>			V94	
Other (please specify)	<input type="checkbox"/>			V95	

105

106

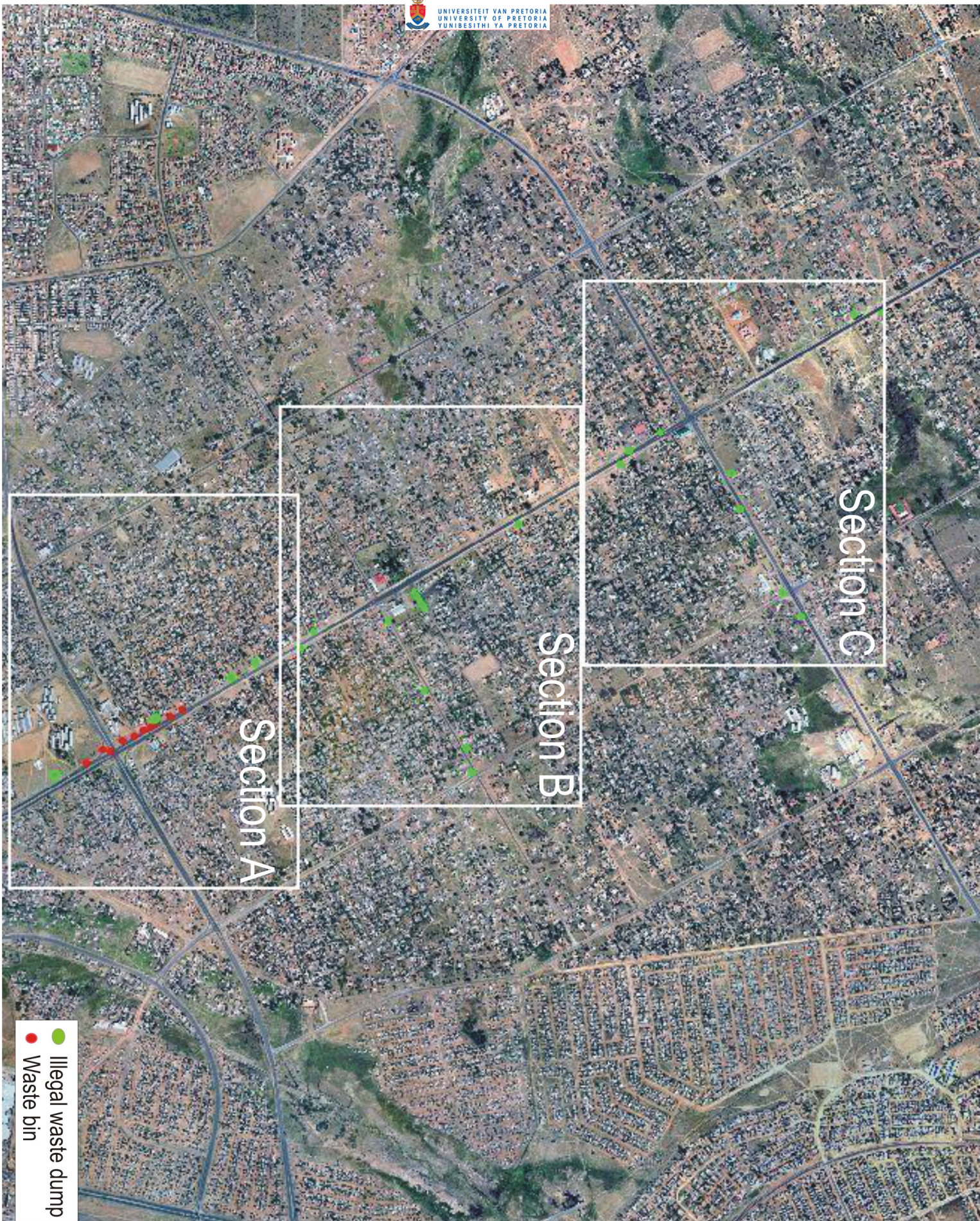
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109

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Appendix D: Figure 6.1 Orthophoto (enlarged).



- Illegal waste dump
- Waste bin

